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CONTENTS.

☞ An asterisk (*) denotes an illustrated article

EDITORIALS—
- London Treatise on the Manufacture and Distribution of Coal Gas 61
- The St. Louis Controversy 61
- Commissions 62
- The American Architect and Building News 62
- Metric System 62

On Naphthaline 62
Purification of Gas from Carbonic Acid 63
On the Combustion of Coal Gas to Produce Heat, and the Theory of the Structure of Flame 64
The Longest Bridge 65
The Manufacture of Coal Illuminating Gas 65
Address of Mr. Price at the August Meeting of the New England Association of Gas Engineers 66
The Coals of Indiana 67
On the Proximate Composition of Coal-Gas 68
Process for the Manufacture of Soda from Seaweed by Endosmotic Lixiviation 69
A Dirty Mean Trick 70
Gas-Light Intelligence 70
CORRESPONDENCE—
- High and Low Level Sites for Gas Works 70
- Lowering Water Mains 71

WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

Subscribers would confer a favor upon us by remitting *CHECKS*, or *POST OFFICE MONEY ORDERS*, as we are frequent losers where money is enclosed in letters.

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NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

BOSTON, Jan. 1, 1877.

The Annual Meeting of the Association will be held at the Tremont House, Boston, on Wednesday, February 21, 1877, at 10 o'clock, A. M.

GEO. B. NEAL,
Secretary.

LONDON TREATISE ON THE MANUFACTURE AND DISTRIBUTION OF COAL GAS.

We are informed that the above work will be completed in *about* twenty four numbers and extend through about two years. No one in the business should be without it. To those who have not ordered it we would suggest that they send, at once, names and address. The first two numbers have been forwarded to those who ordered them early. To others the back numbers will be sent, and the work will come regularly every month. Price forty cents a number. Bills will be sent in due time.

THE ST. LOUIS CONTROVERSY.

There has been a contest going on for some time in St Louis which presents some remarkable features to those disposed to invest in gas undertakings. We are unable to give the details of the whole affair; but, as far as we have been able to learn, the facts are about as follows:

The old St. Louis company had a charter granted them for a certain number of years, at the end of which time the city authorities of St. Louis should have the privilege of taking the works and business of the company, upon certain conditions as to valuation, etc., etc.

The charter "expired" about the year 1870; that is, the time at which the city might assume the ownership of the works arrived at about that date. About a year ago, upon the presentation of the company's bills for public lighting, the city fathers declined to pay, on the ground that the works belonged to the city, and that the company had no claim. The gas company claimed that any right that the city might have had had expired, and, moreover, that inasmuch as it has since then entered into contracts with the company for public lighting, and, until the present case came up, has paid the company under those contracts, they had waived their right and were estopped from asserting it.

About the time these contracts were made a new company was started, viz., the Laclede Gas Co., which eventually bought a portion of the old company's district, together with the pipes therein, and (dividing the city with the old company) proceeded to sell gas to the citizens, and to the city, within its territory. Contracts were made with, and paid by the city, as usual, until the refusal to pay the old company occurred, when they refused alike to pay the Laclede.

The next thing was a suit on the part of the city against the old company to recover all profits made since the time when the city might have taken the works, and also against the new company for a portion of their profits, inasmuch as they had bought some of the old company's pipes which they claimed should have been turned over to the city. This was not sustained, however, as the Laclede company had got their purchase confirmed by the city authorities, and the suit was withdrawn, at request of plaintiff's counsel, and the Laclede stands clear of all litigation. Having got the old company into the courts, a receiver was appointed to conduct the affairs of the company pending the suits. This was followed a few weeks since by a "decision" that the city owned the works, and that instead of money being due the company the profits that had been made by the company since the expiration of its charter should have been turned over to the city and, consequently, the company was in debt to the city to a large amount. Far be it from us to speak or think disrespectfully of the decision of any court, and if the statement of the case is correct, there must have been good and valid reason in law for the action; but it is intimated, by some interested parties, that the whole thing was *started* for the purpose of securing some consideration from the old company. They did not respond, and, being of the opinion that either they owned their property or they did not litigation was the result.

The case having got into court no doubt the whole power of the city was brought to bear to secure a decision favorable to it. It would seem to be a hardship upon the stockholders, but if the law is on the other side it is evident that there has been neglect somewhere, on the part of the company, in not providing for the requirements thereof. Here would seem to be a new peril in danger of which holders of gas stocks stand. In addition to all the dangers and risks of the business itself, there would seem to be a liability of losing what they owned, in a manner almost as sudden and inexplicable as that of those who, at this moment, own certain coal stocks which were supposed to be about the only really safe investments that one could have.

The lower court decided that the amount due the city by the company was 207,000, and by a despatch, in the *World* of 13th inst., it is stated that the Circuit Court has issued a final decree giving the city all the works and property of the company, and $40,000 in cash.

COMMISSIONS.

The London *Journal* has been giving some account of the complaints, made through a letter in the London *Times* as to the taking of commissions on supplies purchased;—and the letter has brought many replies, some indignant, some explanatory, and some of a sort of combined character. The *Journal*, for 23rd January, refers to this matter as follows:—

"It seems to be a common belief that all gas officials are highly paid, but no grosser delusion ever prevailed. There are a few—very few—who receive, well-earned, large salaries: but we repeat, without fear of contradiction, that a vast majority of gas-managers are most inadequately rewarded. They are required to know something of many arts and several sciences; they can hardly be said to have any peace night or day; and at times, their duties are of a most onerous character; and when they have done all, they often receive less than a banker's or a merchant's clerk, who has only to make entries and add up figures from ten to four o'clock. Struggling companies may have some excuse for parsimony; but if we might select some of the worst cases of inadequate payment, we should take them from our corporate towns. Here, too, it may be said, there is an excuse, for we have recently read of indignation meetings being held, to remonstrate against the addition of fifty pounds a year to the salary of a most valuable gas officer. We feel bound to insist on this matter, for, in our opinion, it lies at the bottom of all the mischief of which complaint is now made. Pay a man well, and then you may expect or require him to be immaculate. It is, from a moral point of view, sad to think that men require to be bribed, as we might say, to be honest, but such, in a limited sense, is the fact. You must place men above temptation before you can expect them to resist it.

"Mr. G. Livesey's letter is a fitting answer to the letter of the "Commission Abolitionist," which we quoted last week. It will be seen, practically, Mr. Livesey admits the truth of most of the allegations of the previous writer, and only controverts the too sweeping charges made in the letter. The offers of bribes are not universal, nor are their acceptance universal. Mr. Livesey agrees with us in putting the blame on the right shoulders. The old serpent has, in the lapse of time, assumed many forms; and if after, say, six thousand years, he reappears in what is called the nineteenth century in the shape of a coal contractor or meter maker, with a golden pippin in the shape of a commission, who is to blame? Certainly not the "innocent victim," who takes the pippin, and, it may be, gains a knowledge of good and evil in the columns of the *Times*, but the scaly monster who first offered the temptation, and then exposed his innocent victim. A curse was pronounced on the original old serpent, but we suspect that many curses will attend his representative of to-day."

There is a good deal of sound sense in these remarks upon compensation. If a man is competent to perform the duties of superintendent or engineer of a works, he is entitled to such pay as will enable him to give all his mind and energies and time to the advancement of the interests entrusted to his hands, and any man who does this has neither the disposition or the time to be looking out for his "divide." If any company is shortsighted enough to deliberately make an arrangement with its manager for a very small salary, with the understanding that the rest of his compensation must be secured "elsewhere," that company may be very sure that the ordinary human will be most of the time watching "elsewhere," and as little as possible attending to the works.

Unless such an agreement is expressly made and understood, between the company and its officials, we maintain that, under *no circumstances*, has the official any shadow of right to accept any commission, compensation, or consideration of any kind, from parties supplying material, apparatus, etc. He agrees to *serve the company* when he accepts their pay for his services. It matters not whether the company would have to pay just the same for what they bought in either case. That is not the question. The question is—can a man serve two masters? We think we could (if necessary) refer to very good authority to prove that he can not do it.

It is a question of personal integrity, which no man who posseses a true self-respect would ever allow to be brought in question by such practices as seem to be agitating our English brethren just now.

We present this matter not that we would for a moment suppose that any respectable manager, or other official of our gas companies, would have any personal interest in the matter; but we do suppose that temptations exist here as well as in England, and it is to enable those who may be so unfortunate as to hear the hiss of the serpent to recognize exactly what it means, and what it will lead to, that we would urge a combined effort on the part of all honest men to bruise the serpent's head.

We might refer to the wide-spread demorrlization of the times as resulting from civil war, extravagant speculation, overdone business, etc., etc., but, while that might indicate a possible cause, it is no excuse. Heaven knows that there are enough *imaginary* evils, both in design and in act, attributed to the gas fraternity; but let there be no *real* cause for reproach upon the profession, and it will emerge eventually from the mists of detraction and takes its place, where it belongs, as the peer of any industry or profession in skill, success and integrity.

THE AMERICAN ARCHITECT AND BUILDING NEWS.

This Journal has completed its first year with great credit to all concerned in its management and publication. It has filled a place in the literature of the day which every man, who believes that a profession should be guided by correct principles and good taste, will acknowledge was vacant before. The high character of its articles, the whole tone of the journal, will secure for itself permanence; and as a record of progres in American Architecture, and its adjuncts, it is valuable for reference as well as interesting for study.

METRIC SYSTEM.

The American Society of Civil Engineers, by a vote of 138 to 93, adopted a resolution to the effect that they would, by all legitimate means, further the adoption of the Metric Standards as the sole authorized standards of weights and measures in the United States. This is a decided advance, and we trust that the work will be successful.

On Naphthaline.

By R. H. Patterson.

Any one who even cursorily glances at the proceedings of the various associations of gas managers, now so usefully established both in this country and in America, will observe that no subject is so frequently discussed as naphthaline, and what to do with it. The importance of the question is undoubtedly great, because the choking of gas pipes with this substance both on the works and, still more embarassing, in the street mains and service pipes, occasions a serious difficulty and no small expense to gas companies. The companies are not only obstructed in the work of supply but they are also frequently blamed for supplying gas of too low illuminating power when really they are amply fulfilling their obligations in this respect.

But it is not merely, indeed it is not so much, the practical importance of the question that causes it to be so frequently discussed as the perplexity of the subject. Mr. George Lowe, a high authority, because a thoughtful man, almost at the close of his long and useful career, when appealed to for advice about these troublesome naphthaline deposits, said frankly that he could tell nothing about it. The diversity of opinion which still prevails on this subject is fully reflected in the frequent discussions, and in the variety of methods proposed, some of them obviously useful, and others of only imaginary utility. Nevertheless, thanks to these almost ceaseless discussions and interchange of experience among gas managers, the naphthaline question, although not yet solved, has certainly been advanced far beyond the point of absolute perplexity at which it stood for some years ago as stated by Mr. Lowe.

The question as colloquially expressed in the discussions of the several associations is "How to prevent the formation of naphthaline?" which, as the speakers themselves must be aware, is an incorrect phrase, because the "formation" of naphthaline takes place in the retorts, and this part of the subject is never dealt with. Correctly expressed (as it usually is in the titles of the papers) the question to which gas managers give their attention is "how to prevent naphthaline deposits in gas pipes. We may deal with the various points of detail at issue in these discussions on another occasion; but for the present, and as a starting-point, we wish to call attention to a very remarkable fact, namely, that although the question is nominally the same, although these discussions go on just as before, the point of view from which the question is regarded is now in reality wholly, or nearly wholly changed. The mind's eye of the speakers, which used too look north (so to speak), now looks south. The universal opinion used to be that naphthaline was simply and solely an impurity, and a most troublesome one, a foreign body that must be got rid of, if possible, before the gas left the works, and at the very earliest possible stage of the purification; and the question as then discussed was—Is it possible to get rid of the naphthaline—to take it all out of the gas—and, if so, by what means can this be done? *Now*, the point of view is diametrically changed, and the question really is—How can we *retain* the naphthaline in the gas? The prevention of naphthaline deposits is now sought for, not by taking out the naphthaline, but by trying to keep it in. Instead of accepting it as a hopeless impurity, which must be extracted from the gas in order to avoid its inevitable deposit somewhere or other in the pipes, gas managers now look at in a hopeful spirit, and ask one another—Can we not prevent these troublesome deposits without sacrificing the naphthaline, which is the most light-giving of all the constituents of coal gas? In short, the motive of discussion now is, not how to take out the naphthaline, but how to find

means, if possible, to make the gas retain it permanently.

We do not say that this right about-wheel of opinion is clearly recognized, nor is it yet fully accepted. In the discussions some men are found speaking from the old point of view and others from the new. Indeed, at the meeting of the Association in 1874, two papers were read upon naphthaline deposits, one of which aimed at getting rid of the naphthaline altogether, while the other aimed at keeping it all in. What is more curious, some processes which were highly recommended by some speakers as a sure means of taking out the naphthaline, were equally suggested by other speakers, who advocated the retention of the naphthaline, and who recommended the said processes for this totally different purpose. Any one would naturally expect that when the same process or material was recommended for two diametrically opposite purposes, so singular a circumstance would have attracted notice, and would have led to the inquiry as to what is the true action of the processes in question—which really is the important matter to be determined. But the fog will soon clear. Before next year, let us hope, the present uncertain or absolutely conflicting motive of the discussion will assume a definite form, and the facts, which are still so oppositely interpreted, will be subjected to a strict investigation; and it is to help in this clearing-up process, and to narrow the question to the practical points at issue, that we offer the present remarks.

We think we perceive, and will mention in the sequel, a hitherto unnoticed cause, or change of circumstances, which may partly account for the change of opinion now gaining ground relative to the mode in which naphthaline ought to be dealt with. But firstly, as to the main point at issue, and which has yet to be determined. Is the object of inquiry to be to prevent deposits of naphthaline by taking this substance wholly out of the gas; or is the prevention of deposits to be sought for by taking means to retain the naphthaline in the gas, *i. e.*, by keeping it as an uncondensed vapor up to the point of consumption? This obviously, is the first point upon which an agreement must be come to, if discussion is to have a direct and proper object.

When that primary question is settled, inquiry should next be directed to the means to be adopted for carrying out one or other of these objects. On this part of the case the same suggestion is made on both sides alike. Those who advocate the extraction of the naphthaline recommend naphtha (or other similar substance) as the best means of taking it out; those who support the new view of retaining the naphthaline recommend naphtha as a means of keeping it. Which of these two very opposite opinions is the right one? Be it observed we are not here speaking of the clearing out of naphthaline deposits. Naphtha has long been employed for this purpose, and there is no question as to its efficacy when so used. The point here is as to the use of naphtha to *prevent* naphthaline deposits. whether by retaining the naphthaline in the gas or by taking it out; and the question is, which party is right—those who say that naphtha will take out the naphthaline, or those who say that it will keep it in?

Undoubtedly naphthaline should be retained in the gas, if possible, because this substance is the most light-giving of all the constituents of coal gas. But is it possible to keep it in? The old opinion, which is still largely held, that it is impossible to retain the naphthaline in the gas, and therefore that it is indispensable to take it out of the works, has a strong basis of fact to go upon. Naphthaline is a solid—at the ordinary temperatures it naturally exists in the form of crystals; and it is those crystals which produce the serious choking up of gas pipes. Moreover, when it exists in the form of vapor, as it does when produced in the retorts, its specific gravity is about nine times that of coal gas. What use is it then, say the old party, to endeavor to keep a solid like this in the coal gas? It is hopeless, impossible; therefore, since we must get rid of those troublesome deposits which choke our pipes, the only course is to take out the naphthaline on the works, and at the earliest possible stage.

On the other hand it is to be borne in mind that olefiant gas and the richer hydrocarbons have a capacity to hold naphthaline in solution as a vapor, not by any chemical union or combination, but simply in the same way as water will hold sugar in solution as a liquid. Coal gas consists of three different classes of substances: (1) true gases, such as hydrogen, marsh gas, olefiant gas, and acetylene; (2) vapors of liquids, such as benzole; (3) solids, of which the chief is naphthaline. When these vapors of liquids are in the pipes they attract little attention, being undistinguishable from the tar and water; but when the vapors of solids condense they are noticed at once, choking up the pipes. Both of these kinds of illuminating vapors (which *per se* condense at the ordinary temperatures), in so far as they remain in the gas, are kept in a gaseous form by being held in solution by the richer or olefiant elements of the gas, which, it is true, is a very small portion of the gas, only 3 or 4 per cent., but then the naphthaline is merely a trace. Upon such grounds, therefore, it becomes evident that, under certain conditions, it is possible that the whole of the naphthaline *may* be retained in the gas.

But what are these conditions, and how far is it possible or practicable to insure their observance? The chief conditions are the quality of the gas and the temperature to which it is exposed. *Ceteris paribus*, the richer the gas the greater is its capacity to hold naphthaline in solution, and the lower the temperature the more readily will naphthaline drop out of the gas and be deposited in the pipes. We doubt if the illuminating power be a perfect measure of the presence in the gas of those richer hydrocarbons which have the capacity to carry the naphthaline by keeping it in solution as a vapor; because gas of the same illuminating power may contain either a comparatively large proportion of marsh gas (carburetted hydrogen) and a smaller proportion than usual of the richer hydrocarbons; and doubtless gas of the latter kind will carry naphthaline better than gas of the former kind. But, for all practical purposes, we may regard the illuminating power as indicating the greater or less capacity of the gas to retain naphthaline. Accordingly, we think experiments ought to be made to ascertain what is the carrying power for naphthaline of gas of different degrees of illuminating power under a fixed temperature. For example, take a given temperature, say 60° Fahr., and ascertain the carrying power for naphthaline of gas from 12 candle power upwards. And to make the experiments complete, the "carrying power" ought also to be determined for these different kinds of gas at different temperatures, say from the freezing-point up to 80°, which is a higher temperature than it is possible to keep the gas at up to the point of consumption.

We are inclined to think that the great change of opinion as to the mode of dealing with naphthaline, which has recently taken place, is to some extent owing to gas in many places being now made of a higher illuminating power than formerly, so that the naphthaline is less prone to deposit itself than used to be the case. Anyhow it is indispensable that some such experiments as those above suggested should be made before any correct decision between the old opinion and the new one can be arrived at. Perhaps it may be found that both opinions are correct under certain but different circumstances, and that, while in most cases it is expedient to endeavor to retain the naphthaline in gas, in others, and with gas of inferior quality, such an attempt may be hopeless. and the only object ought to be to take out the naphthaline altogether.

Lastly, as to the effects of naphtha when employed with reference to the naphthaline. Does the naphtha, now frequently employed, take out the naphthaline, or keep it in? One party appeals to the non-formation of naphthaline deposits, when naphtha is used, as a proof that the naphthaline is taken out; the other party appeal to the same fact to prove that the naphthaline is retained in the gas. But the mere fact of the absence of naphthaline deposits leaves the question entirely in doubt; because, as is obvious, the non formation of these deposits may be due as well to the one cause as to the other.

It may be due either to the naphthaline being kept in the gas by the naphtha, or to the naphtha having taken it all out. For our own part, we hold that naphtha will have either the one effect or the other, *according as it is employed*. If it is brought or kept in contact with the gas as a cool liquid, it will certainly take out the naphthaline; on the other hand, if the naphtha be brought in contact with the gas in such manner that, from the heat of the gas, it is vaporised, then it will act simply by enriching the gas just as if cannel coal were used in the retorts, and thereby increase its power of carrying, or keeping in solution, the naphthaline.

When these questions are correctly determined, the naphthaline question will be narrowed to a few simple matters of detail, which may be easily settled.

Purification of Gas from Carbonic Acid.

Twenty years ago the adoption of oxide of iron in place of lime was hailed by the gas world as a great economy, whereas it was a great mistake. The mistake arose from the long-continued error of paying no attention to carbonic acid as a most detrimental substance in illuminating gas. The use of an alkaline material (whether lime, soda, or a portion of revivified gas liquor) is indispensable—restricting the use of oxide of iron to "catch" purifiers for the absorption of the partial overflow of sulphuretted hydrogen from the alkaline vessels, by which the main work of purification is effected thoroughly and profitably.

Since this article was written, and indeed since it was in type, I have been enabled to give the result of experiments upon the illuminating power of gas purified in the ordinary way by oxide of iron, and also of the same gas after being deprived of its CO^2 by being passed through lime. The experiments were kindly made for me by Mr. Sugg, of Westminster, whose well known ability and carefulness in conducting experiments of this kind are a guarantee for the correctness of the results.

These results fully confirm my statements in the foregoing article as to the great gain in illuminating power obtainable by extracting the CO^2. They show that gas which, when purified by oxide of iron in the ordinary manner, gives the light of 17·2 candles (tested by Sugg's standard burner), gives a light of 18·77 candles after its CO^2 has been extracted, showing a gain of 9·2 per cent. in illuminating power.—R. H. Patterson, in *Engineering*.

The Combustion of Coal Gas to Produce Heat, and the Theory of the Structure of Flame.

By JOHN WALLACE.

[From "Journal Society of Arts."]

[Concluded from page 47.]

Every one who has seen the coal stove in use on the Continent must be aware that its great heating power is due to a large radiating surface, and nothing else than a large radiating surface would give such a result. The same rule applies to the gas stove, which should be at least six feet high, and so arranged internally that the products of combustion should pass over the whole surface before escaping.

The diagram shown represents a section of a gas stove six feet high and fifteen inches diameter, with a partition dividing it into two parts from the bottom to within six inches of the top. The products of combustion from the burner, pass up to the top of the division, then down the other division, escaping on a level with the burner, after having travelled nearly twelve feet over a thin iron plate forming the radiating surface of the stove. The hot spent gases not only pass over a large heating surface, but they travel slowly, allowing the greatest time for the heat to pass through.

The speed of the draught (being regulated by the difference of the temperature of the two columns) is always in proportion to the amount of gas being burnt, and the result is a balanced draught which never requires the control of a damper.

Let me show you by experiment the advantage of this arrangement.

A syphon of stove piping represents the stove case with its two divisions, and a small burner is placed below one end. The products of combustion pass up one half of the syphon and down the other, escaping at the level of the burner. To render this apparent I pass some smoke up from beside the burner, and you presently see it emerge at the outlet, showing that there is a continuous current through. The products of combustion are losing heat through the sides of the pipe as they travel along it, and the thermometers fixed half along, and at the end, will give us an idea of the rate of radiation. The thermometer at the bend of the syphon stands at 220 degrees Fah., and that at the bottom or outlet indicates 95 degrees Fah., so the difference between these two temperatures represents what would be the loss from a gas stove, if the chimney were put at the top instead of at the bottom, and shows the absurdity of placing the outlet at the top.

The disposal of the products of combustion is the next matter for attention, for, although they may be carefully turned into a chimney, they may be unable to ascend by reason of down draughts. This difficulty often occurs in heating conservatories having low chimneys, and situated frequently in placed where the force of the wind accumulates. There is the risk of extinguishing the gas which may afterwards escape, causing serious risk of explosion, and there is also the danger of having the products of combustion blown in among the plants which would soon kill them.

The problem then is, how to prevent the down draught without closing the chimney, and thereby arresting the products.

The disturbing force of the wind down the chimney must be met by another equal force acting at the same time in an opposite direction. These two forces will meet and neutralize each other, and the products will continue to escape, as in calm weather.

I shall again have recourse to experiment, to show how this may be done.

Here is a box representing the stove case, which is placed beolw the syphon pipe. A flame burns in the box, which is air-tight with the exception of a small tube supplying air to the flame. The outlet of the syphon is extended so as to terminate close to the air supply tube. Both these tubes open in the same direction, and the orifices may be at any distance from the burner. We have now the outlet and inlet terminating so nearly together as to receive the force of the wind at the same time, and, although I make a violent current of air pass against these openings, you see through the glass window of the box that the flame suffers no material disturbance.

A gas heating stove cannot be said to be complete until it is fitted with an automatic regulator, which will only allow the gas to be burnt at such times and in such quantity as will insure the desired temperature.

I shall now show you an apparatus designed for this purpose, which owes its movement to the expansion and contraction of air confined in a closed vessel. Air is remarkable for the small amount of heat requisite to change its volume. An increase of one degree Fah will expand 491 cubic feet of air into 492 cubic feet; and, if it is not allowed to expand, by being confined, it will exert a pressure equal to a column of mercury one sixteenth of an inch in height. A difference of a very few degrees, therefore, can easily accumulate force to close or open the gas orifice of a stove.

The second diagram is intended to show how this may be put into practice, and such a regulator will work on a difference of two degrees Fahr, lighting, adjusting, or extinguishing the burner as heat may be required, for weeks or months together.

The mode of action is as follows:—A thin copper cylinder of a certain capacity contains the air which is to regulate the gas by its expansion. The vessel is painted a dead black to render it the more susceptible to absorption or radiation of heat, and it has on it a small valve, the purpose of which will presently be described. A small pipe leads from the expansion chamber to one end of the inverted sypon, containing mercury. The other end of the syphon has within it a tube suspended over the mercury, within its mouth at about one-eight of an inch from the surface,

The gas to be burnt enters the cup at one side, and passes over the surface of the mercury into the centra tube, up which it passes on its way to the burner in the direction of the arrows. In addition to this, a tube takes a supply of gas to a small flame burning constantly beside the burner. As the air is confined in the vessel, the tube, and the cup, any increase of volume will depress the mercury in the cup, raise the level in the tube, and decrease the space below the central tube by which the gas escapes to the burner; and if the air continues to expand, it will close it completely and cut off the gas. Then the surface of the mercury around the central tube is acted on by the pressure of the gas while the surface within the tube is free, so the mercury within rises to a height proportionate to the pressure of the gas.

When the mercury begins to fall by reason of the cooling of the air in the expansion chamber, it still retains a higher level within the central tube until its gravity overcomes the pressure of the gas, when it falls clear of the tube, allowing a free rush of gas to ignite the burner immediately by the aid of the coustant flame. All that is necessary to set this regulator is to open the valve in the expansion chamber, and light the burner. When the desired temperature is obtained, the value must be closed, and a sample, as it were, of air at the desired temperature, is shut up in the expansion chamber. Any alteration of temperature outside the chamber will effect the volume of the air within, causing a corresponding adjustment of the gas. If the gas were turned slowly on and off, there would be an escape each time it was lit and extinguished, but in this case the supply and cut off are sudden, while the adjustment is gradual.

With an apparatus of this kind a conservatory, for instance, may be heated with the greatest nicety. As sure as the thermometer falls below a given point, the gas will be turned on and lighted, and when the sun affords sufficient warmth, it will be extinguished until the temperature falls again.

That absence of sufficient heating surface, which has already been noticed in speaking of the ordinary gas stove, is equally remarkable in most of the hot-water apparatus, where gas is the fuel used. Twenty-four inches is the maximum distance the heat is allowed to travel in contact with the boiler, and from eight to ten inches may be regarded as a fair average distance when speaking of the small apparatus of which the greatest number are sold. Is it any wonder that gas heating has been tried and condemned a hundred, nay, a thousand times; or that the public at large should be thoroughly satisfied that it has in it no element of true success?

I know of only one manufacturer whose hot-water apparatus shows any sign of thorough appreciation of the fuel he has to deal with. The apparatus is shown on diagram No. 3, which has been kindly lent by the inventor, Mr. Ezard, of Bradford, near Manchester.

The diagram represents a double range of hot water pipes attached to a small boiler under which the burner is placed. Instead of carrying the chimney away from the top of the boiler, it is made to pass along the upper range of pipes, emerging at the return bend.

You will at once see how greatly the heating surface is increased, and this is not the only important advantage gained. The time of contact is extended in proportion, and the result is that the products of combustion escape at a temperature only slightly above that of the water. When we remember that water contains 3,234 times the quantity of heat which an equal bulk of air contains at the same sensible temperature, it will be evident that very little of the gas heat is going to waste.

No real progress can be made in the application of gas to heating until the following facts are fully recognized. No apparatus made to burn coal fuel is fit to be used for gas fuel, the condition necessary to ensure good combustion being totally different. Gas fuel requires a large heating surface, and a very slow chimney draught, barely enough, in fact, to carry off the product; and this draught must not be disturbed.

Gas at 3s. 9d. per thousand feet cost 1½d. per lb, and yet it is now well known that cooking may be done with it not only better but more cheaply than with coal.

I shall now proceed to make a comparison between gas and coal as fuel for heating, and the figures will require very little to be added by way of comment.

Let us assume, as a basis, that coal cost the user 26s. per ton, and gas at 3s. 9d. per thousand feet in London, and on these data examine the cost of obtaining an equal amount of heat from the two substances.

In 1866 Dr. Letheby and Mr. F. J. Evans demonstrated that 1 lb. of coal completely burnt would produce the same amount of heat as 13 cubic feet of coal gas.

From the estimates of Dr. Neil Arnott, Mr Edwards, author of "Our Domestic Fireplaces," and other authorites on this question of the heat utilized for warming a chamber by burning coal in a common open fireplace, it appears that on an average, one-eighth, or 13 per cent. of the total heat of the coal is really available for the desired purpose. Eight pounds of coal would, therefore, be required to produce as much heat in a room as would be given off from a three-light chandelier burning 13 cubic feet of gas in one hour.

Their relative prices would be as follows:

	d.
8 lbs. of coal at 26s. per ton.....	1.112
13 cubic feet of gas at 3s. 9d. per 1,000.....	.585
Difference.....	.527

In other words, the cost of the same amount of heat in the two cases would be as 11d. to 6¼d., which is tantamount to saying that the coal heat costs 90 per cent. more than gas heat. As it is not wholesome to allow the products of combustion from a gas stove to escape into a room, a liberal sacrifice might be made to get rid of them by means of a chimney, without bringing up the cost of the gas to that of the coal.

There are certainly many methods of using coal which render it more economical than gas, but most of them are expensive to apply, and none possess all the advantages of gas fuel. If the figures just quoted are to be relied on, gas is no longer to be regarded as a luxury for the wealthy alone. The poorest classes have generally the worst constructed fireplaces as re-

gards heating power, and buying their coal in small quantities, they pay a higher price for it than do those who buy by the ton. It should be an inducement to the public to know that the use of gas in the daytime is more likely than anything else to reduce the price of it by giving uniform and complete employment for the apparatus at the gasworks, and it is neither impossible nor even improbable that at no very distant date coal or other gas may almost entirely supersede the fuel at present used in the dwelling of all our large towns.

There is one other application of gas heat to which it will on the present occasion be possibly only to refer briefly. It is the raising of steam to drive small engines of not more than four horse power. The demand for engines of this class is already very great and a good substitute for the coal furnace is much needed, not only because it affects the insurance of a building, but also because a small fire requires much more vigilant attention than a larger one. There are already many gas-heated boilers in London and elsewhere, but they appear to be all constructed after the pattern of the coal-fired boiler, and the inevitable consequence must be a considerable waste of gas. The rules already detailed for the construction of heating apparatus apply equally to steam boilers. There must be the balanced draught, the large heating service, and the greatest possible distance for the heat to travel before leaving the boiler. There must also be high steam pressure, and an automatic regulating valve on the gas pipe actuated by the boiler pressure, so as to turn the gas down as soon as the steam approaches the blowing-off point, and thus use fuel only as the rate power is required.

Such a boiler is already in the hands of a well-known firm of engineers, who intend to manufacture it in conjunction with small sizes of the alrendy famous Willan three-cylinder engine. Results of the most satisfactory character have confirmed the experiments already made, and an exceedingly useful and compact apparatus may be expected.

There are various facts among the foregoing remarks which, if summarized, may lead to some useful conclusions regarding the constitution of the solid flame. Let us take the well-know Bunsen flame as a basis of comparison. There is the conical space within the flame, then a sheath or envelope of flame described by Faraday as the zone of partial combustion, and outside of all a second sheath or envelope, the zone of complete combustion. Although air has been mixed with the gas before it reached the flame, is is not sufficient to render the gas combustible. The mixture of air and gas ignites first around the edge of the tube, because there it meets the oxygen most readily, but the center of the rising column of gas and air has to travel to the top of the hollow cone before it can meet the oxygen of the air, which rushes into and combines with the flame with extraordinary rapidity. The thickness of the flame surrounding the hollow cone represents the distance the oxygen travels before it is combined with the gas, previous to escaping upwards as carbonic acid, at a temperature which greatly increases its volume. Part of the oxygen is arrested in the outer sheath or zone of perfect combustion, and part presumably passes into the zone of partial combustion, producing a carbonic oxide flame, as which material it passes into the outer part, receives its complement of oxygen, and becomes carbonic acid.

It has already been observed that small flames require less air pre-admixed than large ones; this is due to the greater surface which they present to the air in proportion to their bulk. The oxygen has consequently a less distance to travel into them.

In Table No. 1, a 7-16th of an inch burner would only bear 1½ volnmes pre-admixed before becoming solid, whereas a 2-inch burner would require a mixture of 4·6 volumes to solidify it. If the small burner received more than 1½ volumes, the flame immediately descended and burned within the tube, its position in the tube depended on the excess of the pre-admixture. Before the flame descended, it exhibited the bright green film across its base, indicating the best state of combustion, and it retained the green film even when burning half way down the tube.

Now, when we remember that it requires nearly 6½ volumes of air to consume the gas completely, it is evident that the amount pre-admixed is not enough even to produce a carbonic oxide flame, which requires just one half of the total amount. If, then, the combustion is complete, the flame must receive its complement of oxygen through the top of the tube, making its way through and against the current of products of combustion, whose velocity is increased by expansion into six or seven times their original volume.

Leaving the small flame, let us turn to the large one. The primary conditions are here very different. In the first place, it has only one-tenth part of the surface, in proportion to its bulk, that the small flame has; and in the second, the amount of air pre-admixed is 4·6 volumes, or about 40 per cent more than that necessary to produce a carbonic oxide flame. The flame is perfectly solid, from the green beads where it commences, up to the top. There is no apparent difference in the temperature of the flame from the center to the outside, and the green beads (those most delicate indexes of any change in the proportion of oxygen in any part), are exactly the same in color and size at the center as at the outer edge. The platina wire, when suddenly placed across the flame, heats apparently at the same rate in every part immersed; so there is much reason to suppose that this is a carbonic acid flame, having neither the zone of no combustion or that of partial combustion.

It must not be regarded as a group of separate flames, as the beads have no separate supplies of air; besides, a solid flame can be produced without the perforated cap, by making a sufficiently intimate mixture of the air and gas, as in the case of the smaller flame. Since the green beads are so uniform in size and color, we may reasonably conclude that they are burning under the same conditions, and one of those conditions is that the two and a quarter volumes of air necessary to combustion of the gas must pass to the very center of the flame, giving every bead a uniform and equal supply.

It would be interesting to learn whether the nitrogen of the two and a quarter volumes of air accompanies the oxygen into the flame, or whether it is partially or wholly dissociated before combining.

The subject has been treated throughout from the point of view of an engineer rather than of a chemist, and more with a view to getting at the simplest and best modes of burning coal gas rather than of analyzing the phenomena of combustion.

The work of the chemist has been a good deal limited by the apparatus with which he has experimented; and it is with a hope that an approved form of burner may assist in the further analysis of a most important subject, that the matter has been brought before you.

The Longest Bridge.—A piece of engineering enterprise of great magnitude and importance is just now making rapid progress, namely, the new viaduct across the estuary of the Tay. The first stone of the Tay bridge was laid on the Fifeshire side of the Tay in the month of July, 1871. The estimated cost of the undertaking was from £200,000 to £220,000. The object of the undertaking was that of connecting the important manufacturing town of Dundee with the North British Railway Company's branch between Edinburgh and Tayport. The length of the bridge is 10,321 feet, and in shape it is not unlike the letter S. It is the longest bridge over a running stream, in the world. On this account its construction was looked upon as one of the most important engineering works of recent times. Nor was it in respect of length alone that it claimed to be unique, and threatened to tax all the constructive resources of its builders. It was beset with even greater trials on account of the Tay being a tidal river, liable to enormous floods and exposed to blasts of wind from east and west, which seemed likely not only to hinder the progress of the work, but to destroy such progress as had actually been made. For a long time very little progress was made in the work of construction on account of the experimental character of the operations and the frequent accidents that befell.—*Coal Trade Journal.*

The Manufacture of Coal Illuminating Gas.*

By Alfred P. Trautwein, M. E.

Continued from page 26.

METHODS OF PURIFICATION.

The several methods of gas purification as now generally practiced, involve the use either of hydrate of lime or of oxide of iron, both native and artificial, or of a combination of both. We might mention, in addition to these, a number of metallic salts and such substances which have been suggested as purifying materials, but which are used only to a very limited extent; we may have occasion to revert to these further on, and we will, therefore, first take up the subject of

LIME PURIFICATION.

The first attempt at purification by means of lime; in fact, the first effort to purify gas at all, was made by Clegg when he became connected with the Chartered Gas Company. He passed the gas through cream or milk of lime; but this process was soon abandoned, the main cause of its rejection being the fact that the lime-water required to be constantly agitated by means of mechanism, and that the back-pressure upon the retorts was very considerable, the exhauster not existing at that time. A further drawback consisted in the difficulty of getting rid of the refuse material known as "blue billy"; the wet lime process, it is true, was a most efficient mode of purification, but the objections just enumerated were quite sufficient to cause it to be superseded by the so-called dry lime process, which was first suggested by Phillips in 1817. It differs from the former in this particular, viz., that the quantity of water which is mixed with the lime is much less, being but little more than is requisite in slacking it.

Hydrate of lime readily combines with the carbonic acid to form carbonate of lime, and takes up the sulphur and cyanogen compounds, forming with them the sulphide and cyanide of lime respectively; it does not, however, remove the ammonia and the bisulphide of carbon, which latter impurity, fortunately, is rarely present in large quantities. It is not by any means immaterial, however, in which order the above chemical reactions take place, and both theory and practice seem to agree that purification by means of lime will be most effectual, when the following conditions are fulfilled:

First—That the carbonic acid be removed as thoroughly as possible, before the gas enters the purifiers to be cleansed of sulphuretted hydrogen and bisulphide of carbon.

Second—That a certain small percentage of ammonia be present in the gas, since under these circumstances the affinity of the hydrate of lime for the H_2S and CO_2 is largely increased.

Third—That sulphide of calcium be next formed by the action of the H_2S upon the $CaO\ H_2O$. The sulphide of calcium in its turn will then readily decompose the bisulphide of carbon, which can be eliminated in this manner only.

It has, therefore, often been proposed to remove the carbonic acid, partially at least, by thoroughly scrubbing and washing the gas by means of liquor, thus greatly relieving the purifiers; the lime now thoroughly removes the sulphuretted hydrogen, and the sulphide of calcium thus formed continues and effectually completes the process of purification; the small quantity of ammonia which still remains in the gas is too insignificant and harmless to require removal.†

We will now proceed to examine the various modes of preparing and using the hydrate of lime.

As generally practiced, the method of preparing the hydrate of lime for use in the purifiers consists in carefully though thoroughly slacking the quick lime, as received from the kiln, two or three days before

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* A Graduating Thesis at the Stevens Institute of Technology.

† The above statements, substantially, will be found fully corroborated in a communication to the American Gas-Light Journal, February 2nd. 1876, p. 47, entitled, "An Accident in the Purification of Gas."

use; it is subsequently wetted for a second time, the water thus added being just sufficient to allow the granular powder of hydrate to form a slightly coherent mass upon gentle pressure by the hand. It is then ready for use and is placed into the purifiers in a series of layers varying from two inches to six inches in depth. Great care is taken to distribute the lime upon the trays as uniformly and as loosely as possible, in order that but little back pressure may be experienced; for this reason, also, many managers add to, and intimately mix with the lime, a small quantity of coke breeze, say from five to ten per cent. of the bulk.

The subject of lime purification has of late years received a great deal of attention on the part of the American Gas-Light Association, the immediate cause being the discussion of what is known as Forstall's method of preparing the hydrate of lime. This differs from the ordinary mode simply in this particular: that a larger quantity of water is added to the slacked lime; it should be noted in this connection that the lime loses in bulk when thus prepared, the diminution amounting generally to from 10 to 15 per cent, and that, for this reason, any comparison between the results obtained by Forstall's and the ordinary method should be based upon the number of cubic feet of gas purified per bushel of *unslacked* lime. This method of prepaaing the hydrate of lime is now practiced to quite an extent, and it has variously been modified; one example, however, will be fully sufficient to illustrate the process in question. The lime is first very carefully slacked, and to every measured bushel of lime thus prepared, three-quarter gallon of water is added; the mixture is thoroughly worked up and is then thrown up in a heap, is covered over with heavy canvas and is left in this condition for two or three days. When required for use a quarter gallon of water is added, and it is then ready to be put into the purifiers, which are generally arranged for two or three layers, the depth of lime on each layer varying from six to eight inches, or even more. It has been found that thereby the pressure in the purifier is not increased to as great an extent as one might be led to suppose, by the increased density of the lime when prepared in this manner; this is rendered still more remarkable by the fact that the foul lime from the purifier presents the appearance of a very hard and compact mass. It has been claimed that a bushel of unslacked lime, when prepared according to Forstall's method, will purify at least twice as much gas as when prepared in the ordinary way, while in several instances we have seen it stated that as much as three times the usual qqantity of gas was purified.

Lime purification, it must be admitted, is very efficient in every respect; it is, nevertheless, open to one very serious objection. We refer here to the difficulty which the gas managers experience in getting rid of the refuse or foul lime; it has been employed, it is true, to a limited extent as manure, but it must be used with great care in order to yield good results: while it has recently been suggested that it would be of value in tanneries. The uses to which it may thus be put are the exception rather than the rule, and gas managers generally consider themselves fortunate when permitted, at their own expense, to fill in some low or marshy locality in the immediate neighborhood of the works. Such a proceeding, however, is very liable to prove a nuisance to the community at large, and then, again, the emanations from the fouled purifiers are generally considered highly detrimental both to the health and comfort of those residing in the neighborhood of the works. In very many cases therefore, sanitary regulations compel the manager to resort to some means of abating the nuisance. This is most readily accomplished by drawing atmospheric air by means of an exhauster through the fouled lime while still in the purifiers and under cover, and by carrying and discharging the obnoxious vapors at a sufficient height by means of high chimneys. Deodorization or ventilation of the foul lime, as this operation is known, is practiced at the Manhattan and Metropolitan Gas Works in New York city.

Many gas managers, however, consider it more advantageous on the whole to employ what is technically known as

IRON PURIFICATION,

since there is no difficulty whatever, as we shall subsequently see, in disposing of the spent material, for which, in fact, there is a great demand. Before examining the individual processes in this direction we will state the general principle which forms the basis for all. The iron is invariably in the form of the hydrated sesquioxide, either in its native state or as produced by the action of various substances upon the more common salts of iron. This has a great affinity for the sulphur compounds in the gas, forming with them the sulphide of iron, but it parts with them equally readily when exposed to the action of the oxygen of the air. These reactions enable the oxide to be used over and over again, when properly exposed to the air, and this "revivification," as the process is called, thus goes on almost indefinitely, the limit being reached only when fully one half of the mass consists of liberated sulphur. Oxide of iron does not, on the other hand, remove the carbonic acid from the gas, and this is one of the chief objections which is being urged against its use as a purifying agent.

Purification by means of oxide of iron has received a vast amount of attention, more particularly abroad, where the necessity of some purifying agent other than hydrate of lime was recognized at a very early date. In consequence the processes for accomplishing this are so numerous, that we shall be compelled to confine our remarks to those which are in more general use.

The fact that the hydrated sesquioxide of iron may be employed in gas purification and subsequently revivified, was first observed, it is now generally admitted, by Laming in 1847; almost simultaneously, however, but independently of him Hills, in England, also suggested the use of revivified oxide. The use of these processes spread very rapidly in Europe, and particularly on the Continent, where lime purification has now generally been abandoned.

LAMING'S METHOD.

This has probably met with greater favor among managers on the Continent than any other of the numerous processes in this direction; we will examine it more closely, since it will serve to illustrate the general nature of them all.

The peculiarity of Laming's method consists merely in the mode of preparation of the oxide of iron, which is as follows: Equal weights of hydrate of lime and of sulphate of iron, known commercially as copperas, are intimately mixed together, a quantity of saw-dust or coke breeze, generally from 2fi to 30 per cent of the bulk of the mass, being added in order to render it less compact; a day or two before use the mass is carefully moistened with water, and then the following reactions will be found to take place. The hydrate of lime, first and foremost, decomposes the sulphate of iron, the result being sulphate of lime and hydrated protoxide of iron; the latter, however, continues to exist in the mass but a short time, since it is rapidly converted into the peroxide by absorption of oxygen. There is sometimes a slight excess of hydrate of lime. The mass is ready for use as soon as it presents a uniformly brown appearance, due to the sesquioxide of iron in its state of minute division.

Laming's preparation acts as a purifying agent, in the following manner: The oxide of iron combines with the sulphuretted hydrogen to form the black sulphide of iron; the ammoniacal impurities, like the carbonate and the sulphocyanide, are completely removed, the former by the sulphate of lime and the latter by the oxide of iron. When the purifying power of the mass has ceased, it is removed from the purfiying boxes and is taken to the revivifying floor, where it is broken up, spread out and diligently turned over, in order to expose it freely to the action of the air. Under these circumstances the sulphide of iron is decomposed, and the sulphur is liberated and is deposited throughout the mass, leaving the iron in its original form of the hydrated peroxide. The mixture, preferably with a small additional quantity of sulphate of iron, is then ready again to serve as a purifying agent, and when spent or fouled once more it is again capable of revivification. In this manner the oxide may be used over and over again, until in the course of time a practical limit to its value for purification is reached in the fact, that the quantity of deposited, inert sulphur and foreign salts becomes so great as to completely envelope the particles of oxide of iron, which thus loses its power of absorbing impurities in the gas. This limit, we may here remark, has generally been found to be reached when the amount of sulphur constitutes 35 to 45 per cent of the weight of the mass.

Laming's process, with a slight modification in the proportions of the several ingredients, is in use in this vicinity only at the Peoples' Gas Works, Brooklyn, E. D.,

Generally speaking, purification by means of oxide of iron, cannot be said to enjoy a very extensive application in the United States. Several processes, however, have been suggested and used, and of which the best known, perhaps, is the

METHOD OF ST. JOHN AND CARTWRIGHT.

In this the purifying mass is essentially a mixture of the native hydrous peroxide of iron, commonly known as limonite or brown iron ore, of iron borings and of charcoal, and it is said to perform its duty very thoroughly. This process is in use in this vicinity at the New York and the Harlem Gas Works, and in the New England States it has been applied quite largely in the smaller works.

Another process of iron purification is in use at the New York Mutual, and at the Citizens' Gas Works of Newark, N. J., and still another at the Peoples' Gas Works of Jersey City, N. J.

Very little requires to be said in regard to the mode of application of oxide of iron when used as a purifying agent. It does not generally differ from that already described in connection with dry lime purification. It has been noted, however, that with oxide of iron a larger surface than with lime must be presented to the gas, the velocity of the current, of course, being the same in both cases; in one instance, on the other hand, the very opposite of this is done, and the entire purifying mass, 15 to 25 inches in depth, is supported by one tier of trays only. The trays themselves should preferably be of wood, since iron trays are rapidly corroded by the action of the salts contained in the mass.

[To be continued.]

Address of Mr. Price at the August Meeting of the New England Association of Gas Engineers.

Mr. President and gentleman: I am here almost accidentally. My rambles in search of health brought me near you, and I took it into my head to come up here and listen to your discussions, believing I should find it both agreeable and profitable. I thank you for the cordial reception which I have received; and if I can say anything which may interest you, I shall be happy to do so. But, really, I don't know what you wish me to talk about. I am not a teacher in the art and mystery of gas making, but I hold it to be the duty of every member of our profession—if I may call it a profession—to be always ready to communicate any ideas he may have bearing upon its character. If you will intimate to me what you wish me to talk about I will endeavor to conform to your wishes. If you desire I will try to explain any process or method in the business of my company which it is proper I should speak of in a public assembly. You have had under consideration several subjects that interest me much, and one of them is the use of oil. I might tell you what we have done in that matter. In common with most gas companies we have been very much troubled with naphthaline. We run pretty high heats—say, brilliant yellow heats, and thereby obtain a fair yield of gas per pound of coal, say about 4·90 to 5. Sometimes we get 5·10 to 5·15, but I

think we do not average more than 4·90. Now, I think it is pretty well settled that high heats develope naphthaline, and, as cold weather approaches in the fall, naphthaline is developed rapidly. Our way of getting rid of it formerly was by the use of cannel coal, say from 5 to 10 per cent. The gas made from cannel seemed to repress the naphthaline. This was the best remedy we knew. For several years we used our Darlington cannel; it cost about $4·25, delivered. It is a good enricher, but the coke produced is poor, and we were obliged to carbonize the cannel by itself, and to sell the coke made from it at half price. This was inconvenient and last fall we decided to experiment with petroleum and test its merits as an enricher. We did not adopt any patent process, but built a small oven, at one end of our retort-house, and set two 10 inch cylinder iron retorts, each 6 feet long, therein. To avoid accidents we placed the reservoir of crude oil outside, and introduced it by a pipe running through the wall of the retort-house. As the gas was distilled it was carried directly to the hydraulic main, and was carried with the coal gas through the condensers and scrubbers to the purifying house, and thence to the holder. We made no attempt to measure the gas made from oil, by itself, and, therefore, we do not know how much gas we obtained from each gallon of oil. We estimated, however, that the oil yielded from 70 to 80 feet per gallon, but of this we were not certain. As to the effect we were certain. Our gas was brilliant, and the naphthaline was repressed and gradually extirpated. As soon as this was accomplished we had no further trouble with naphthaline during the fall and winter. By the use of oil we accomplished two things—to wit, we enriched our gas and we repressed the naphthaline. As to the economical result I cannot speak with exactness. We know what our gas cost while using oil, and we also knew what the gas cost when we used cannel, and I can assure you that the cost was not increased while using oil. Our directors were well pleased with the experiment, and we intend to continue the use of oil, in the manner I have described, unless the future should indicate the unwisdom of doing so.

The quantity of oil-gas made daily was very small, say 1½ per cent. of the entire amount made in the works each day. This is as far as I would go in the use of petroleum as a material for gas-making. I have given a great deal of attention to the question (whether oil can be profitably substituted for coal) and I have no hesitation in saying that it cannot. There are many objections, some of which I will mention. First, the gas made from petroleum is not satisfactory It is so rich in carbon that it cannot be used with any satisfaction because of the smoke. There are two ways of getting around this difficulty. One of these is the use of very small burners; but, if we use a small burner, we have a very fragile flame. Any little puff of air will make it flare disagreeably. Indeed it required but a slight wind to extinguish the flame emitted from one of these small burners. A few days since I saw the lights in a Reading railroad car extinguished in a very unceremonious manner by a moderate gust of wind. One of the excellencies of coal gas is the tenacity of the flame made by it. Another method of overcoming the difficulty arising from the excess of carbon is to dilute the volume of gas with atmospheric air. This method is very objectionable. The gas and the air will not promptly and thoroughly combine; or, if they do, they easily separate or stratify. The result is blowing and great irregularity in the flame. A part of the time you will have a bright, and a part of the time, a blue flame. There is but one true diluent, viz., hydrogen gas; but thus far, I think, all efforts to manufacture hydrogen gas, for this purpose, have failed. When the Gale and Rand process was put in operation at Saratoga, some years ago, our company were importuned to buy the patent and I made a trip to that place for the purpose of learning all about its merits. I came home and pursued the investigation as thoroughly as I was able. After about three months time I wrote my report, and our directors were satisfied that we had better let it alone—and we did let it alone. The owners of the patents, failing to induce our company to purchase, carried their wares to Columbus, and succeeded in making an arrangement with the gas company of that city to make a trial of the Gale and Rand process upon certain conditional terms. In my opinion the experiment was a very unfortunate one for our Columbus friends; for I think it led to the building of works, by the State, for the manufacturing of gas for the State Prison, and other public buildings, by which the gas company lost a large and valuable customer. The company gave the process a thorough trial. A building was erected apart from the main works, to secure safety; and in that building a very complete apparatus for making gas by the Gale and Rand process was placed.

While the experiment was being made I was often at Columbus, and, being on good terms with Mr. Douty (the engineer), I had a good opportunity for knowing the results. The trial continued for six months. At the end of that time I called upon Mr. Douty, and asked for the result. Mr. D. took from his drawer his report to his directors, and asked me to read it for my own satisfaction, and I did so. The report gave a minute statement of every item of cost and of income connected with the experiment, and the conclusion was that it was a failure.

"Gentlemen," said he, in conclusion, "this process has no value for you; I would not advise you to buy it."

In conversation with me about the matter he told me that it was true that gas might be made from oil, by the Gale and Rand process, but that there were too many drawbacks and difficulties to make it desirable. He mentioned the constant accumulation of soot as one of the annoyances. He also said that the cheapness of the gas made was apparent, and not real. I ought to add that the Columbus Gas Company did purchase the patents; but I was told that but a small sum was paid for them, and I am sure their use was immediately abandoned, and has not been resumed.

Another question connected with the use of oil is whether there is not a stoppage of the main, and the service pipes, which will prove very damaging. A Memphis the gas company was put to great trouble and expense from this cause. A tarry substance was carried forward through the mains and into the house pipes. This substance became very hard, and it was found difficult of removal.

Another difficulty connected with the oil process is this; a nasty and stinking substance is carried into the house pipes, and even into the chandeliers and other fixtures, so as to be very annoying. When one turns on the gas he daubs his fingers with the substance I have described, and the smell is disagreeable and hard to remove.

Another most important matter is the effect of oil-gas upon the meters. I am informed, by good authority, that the expense of the companies that make gas for repairing meters, is much larger than that of companies that make gas from coal. This is a most important consideration.

I do not know of an instance, where oil is used as the material for making gas, that the mass of the consumers are pleased with it.

As to the economy of using oil I am sure there is none in the town where I live; and yet, perhaps, there is no point more favorable than Cleveland in this respect. It is one of the great focal points of the petroleum trade. I think there is more oil refined in our city than at any other place in the United States. The Standard Oil Company has a capacity of 11,000 barrels per day, and at the present time is actually refining that quantity every day. Should any of you, gentlemen, be in my town it would be worth while to visit these large refining works; and, if you do so, don't fail to go through the immense cooperage in which 11,000 barrels are made per day, in which to put the oil which has been refined during the same 24 hours. Now, it is fair to presume, that oil can be obtained as low in Cleveland as in any market in our country, and yet, I assure you, that in our city there is no saving in the use of oil, as a subtitute for coal, in making gas.

It may be proper that I should say a word about the kind of coal that we have, on the whole, found best adapted to our use. We have in our market a great variety of coals; and, first and last, we have tested many of them. Our experience has brought us to this conclusion—*that the best coals are the cheapest.* We can buy coals as low as two dollars per ton of 2,000 pounds; and yet we find it for our interest to use coals that cost us four dollars. The coal that we have found best and, therefore, cheapest, is found in Westmoreland County, Pennsylvania. It is known under the general name of Youghiogheny, but there is little difference between the product of several mines in the district lying east of Pittsburg. We use the coal mined at Turtle Creek, about 15 miles east of Iron City. This coal is handled with little breakage, produces liberally of gas, purifies easily, and makes coke of the best quality. I cannot but repeat what I have already said in substance that a poor coal, for gas purposes, is a dear coal. There may be special reasons why a gas company should use a certain coal, although it may be inferior. The Columbus Gas company uses Hocking Valley coal, and it is a poor gas coal in my opinion—but there are special reasons in that case. Still it is doubtful whether that company does not mistake its true interest in using that coal.

It occurs to me that a few words upon the subject of fuel may not be amiss. For many years our company used coke exclusively in carbonizing. When we use coke it takes about one third of the quantity produced to keep up our fires. I think, from what I have heard this morning, that this is better than most works are doing, and I infer that our settings are pretty good. We have no patent system of settings, and our system does not belong to us exclusively. We use an open system, and that is all I can say about it except that it works well. To come back to the subject of fuel I would say that we have had good success in the use of coal as a substitute for coke in carbonizing, and, when our coke market is good, we find a valuable saving in so doing. A year ago I was induced to buy 300 tons of cheap coal, in the hope that it would answer our purpose, but was obliged to abandon it for the reason that the bitumen did not come out a limpid tar, but a hard pitch; and, therefore, we were compelled to abandon it lest our works should be completely choked up. Having still perhaps 200 tons on hand I decided to try it for fuel. The result was entirely satisfactory, and, when the stock was exhausted, we ordered more; and so long as we have a good market for our coke I presume we shall use coal for fuel. The coal I refer to is called Leetonia coal. It burns freely, requires no more work at the bars than coke, and we found that 1,600 lbs., costing us, say, $2.25, would carbonize as much for us as 38 bushels of coke worth, at the works, $3.80. During the season of cold weather the demand for coke is greater than we can supply. By substituting coal for coke we make a nice saving—say four or five thousand dollars per annum.

[To be continued.]

The Coals of Indiana.

From the Seventh Annual Report of the Geological Survey of Indiana, by Prof. E. T. Cox.

Notwithstanding the attention which chemists have given to the analysis of mineral coals, it appears that there is much yet to learn in regard to the nature of the substances formed by its elementary constituents and to the changes which these substances undergo when under the influence of heat and pressure, or the atmosphere at common temperatures. Without discussing in this place the relative merits of proximate and elementary analyses for determining the industrial value of coal, I will proceed to recount the nature of the investigations which have been made in the laboratory during the last year for ascertaining the character and calorific intensity of the Indiana coals.

There are almost endless varieties of mineral coals. They differ in every coal basin, and in parts of the same field and same seam. We may classify them into anthracite and bituminous coals, and a few other well marked types, yet there are shades of difference which gradually blend them together, so that, as a

general rule, the coals at each mine will require a specific study, for they have a distinct industrial value. Coal I, which is usually a non-caking or block coal in the eastern part of the Indiana coal basin, passes into a caking coal a few miles west of Brazil, in Clay county; to the south, at Cannelsburg, Daviess county, the upper part of a correlated seam has four feet of dull-black, close-textured, ringing cannel coal, which gives 5·1 cubic feet of 25 candle gas to the lb. The cannel coal is firmly united at the base to 2 feet of glistening, jet-black, caking coal.

Fossil fuel is usually classified as anthracite, bituminous, lignite or brown coal; and peat. Anthracite is a hard coal, black, sub-metallic, sometimes iridescent (peacock colors), and brilliant, fracture usually conchoidal. It yields 85 per cent. of fixed carbon, and after drying, from 3 to 7 per cent. of volatile matter, burns with feeble flame of pale color. Anthracite graduates into bituminous coal, consequently we have semi-anthracite and semi-bituminous, as the fixed carbon approximates nearest to one or the other. Anthracite is not found in the coal measures west of the Appalachians. In 1864 Prof. Richard Owen and myself examined a seam, from four and a half to five feet thick, of good anthracite, in the Placer Mountains, 27 miles south of Santa Fe, in New Mexico. It was overlaid by a mass of porphyry, and is probably of cretaceous age. For the sake of comparison, I subjoin the proximate analysis which I made of this coal:

Carbon	87·00 per cent
Ash, red	5.00 "
Gas	4·50 "
Water	3·50 "

In the Jennie Lind Prairie, near Fort Smith, Arkansas, there is a seam. four to five feet thick, of semi-anthracite coal, which belongs to the lower part of the coal measures. It is covered by a few feet of shale and soil, and has to be worked by stripping. A proximate analysis of the top and bottom gave—

	Top.	Bottom.
Fixed carbon	82·25	84·10
Volatile matter	12·35	10·70
Ash, light brown	4·00	1·40
Water	1·40	3·80

Closely allied to anthracite is a native coke, found near Richmond, Va.; it is more compact than artificial coke, but contains some bitumen.

All the coals of the Indiana field belong to the class known as bituminous. The principal varieties may be designated as follows:

Caking coal, long flame, gas and smith coal, fat coal.

Semi-caking coal, long-flame.

Block coal, non-caking coal, long flame, dry burning coal, furnace coal.

Semi block coal, long flame.

Cannel coal, long bright flame, dry burning gac coal.

Lignite, or brown coal, is not found in Indiana. It differs from the bituminous coals in containing a large per cent. of hygrometric water and oxygen. It burns with considerable flame, without melting or changing form.

Peat is a fossil fuel which is forming, even at the present time, and furnishes striking evidence of the mode of origin of the older beds of coal. It is found in many of the counties in the north part of the State, and will eventually prove of great commercial value to the people of that region, though the present low price of coal, and its great abundance has thus far caused it to be neglected as fuel. At some of the railway crossings of the Kankakee marsh, peat beds have been probed to the depth of 50 feet.

The following constitute the most marked varieties of bituminous coal.

Caking-coal: non-caking or block coal; semi-caking, or semi-block coal; and cannel coal.

The seams of caking coal in Indiana are locally not less than fifteen in number, and they vary from a few inches to seven and eight feet in thickness. There are as many as three seams, found over a great portion of the field, that have a united thickness of 18 to 20 feet.

Caking coal varies in color, being black, brownish-black, brilliant black, and iridescent (peacock coal). Its fracture is cubical, conchoidal, splinty and obsolete laminæ often appear in its structure.

Most of the bituminous coals of America, England, France and Germany are of this variety. They soften and become pasty, or semi-viscid in the fire at a moderate temperature, and give off a large amount of inflammable gas. When, by the prolonged action of heat, all the volatile matter has been driven off, there will remain a grayish black cellular mass called coke The amount of coke left, or carbon not volatile, varies from 45 to 80 per cent. On account of its melting and running into a mass under the influence of fire, this kind of coal cannot be used in its natural state to smelt iron ores, as it would form into a cake and stop the passage of the blast, but when previously charred or converted into coke, the latter constitutes one of the best fuels for the reduction of iron ores known to the world. The manufacture of coke, however, requires an additional expenditure of labor and involves a loss of at least one-third of the productive heat of the coal.

Block Coal.—In these coals the volatile matter holds about the same relation to the fixed carbon as in the caking coals, but its quality is such that the usual heat produced by burning is not sufficient to render the coal viscid or produce caking, and when the volatile matter is expelled there remains a charred mass of hard, close-texture coke that resembles the original coal in shape and structure; in other words, the coke does not swell and puff up, but retains the laminated structure of the coal. The block coal of Indiana is, therefore, a non-caking, bituminous coal. It has a laminated structure, and contains between the laminæ a soft black substance, that in its fibrous-like structure greatly resembles charcoal. Its composition by proximate analysis is—

Carbon	63·00 per cent.
Gas	32·50 "
Ash, white	1 00 "
Water	3·50 "

An ultimate analysis of the same gave—

Carbon	·8270
Oxygen	·0881
Hydrogen	·0477
Nitrogen	·0174
Sulphur	·0098
Ash	·0100

Block coal may be readily split into sheets or thin slabs in the direction of its bedding lines, but is very difficult to break in the opposite direction. The color is dull-black on the face and glistening or resinous black on the fractured edges. The beds are crossed at right angles, or nearly so, by lines of fractures that appear co-extensive with the field. These fractures also extend from top to bottom of the seam in such a manner that the coal may be readily taken out in great blocks, which gives rise to its name. This severing into blocks, the entire thickness of the seam leaves the face of the mine notched and not smooth as is usually the case in mines of caking coal. The blocks are very compact and will endure rough handling and stocking without suffering material loss from abrasion. This, in a commercial point of view, gives the block coal great value over and above its other good qualities as a fuel for smelting iron and generating steam.

Cannel coal differs from the other varieties of bituminous coals in its physical appearance as well as in the manner of its burning. It has a more homogeneous structure, rings under the hammer, conchoidal fracture in every direction and does not crack and, like the former coal, is usually mined in large blocks. The cannel coal of Daviess county is so hard and enduring that it has been used as a foundation for the engine and mine houses.

Cannel coal kindles readily and burns with a long bright flame which illuminates the room and does not become viscid. The name is derived from the corruption of the word candle.

It is now universally admitted by all well-informed people, that coal is derived from vegetable matter and is the fossil remains of land and water plants such as trees, reeds, ferns and mosses. The change from woody fibre to stone coal having been brought about by chemical action, a species of slow distillation, so to speak, whereby the oxygen, hydrogen and a portion of the carbon of the wood is eliminated in the form of water, carbonic acid and carburetted hydrogen. All the numerous varieties of fossil fuel, including asphalts, petroleum, lignites and peat are mainly, if not solely, due to the modified conditions under which this chemical change takes place, such as presence of water, greater or less pressure. and heat.

On account of its homogeneous, compact structure some eminent geologists and fossil botanists have been led to conclude that cannel coal is formed from water plants which have cellular structure, and not from fibrous land plants. While this may be true in some degree, it is not sustained by all the facts that may be brought to bear on the subject. The Breckenridge, Kentucky, cannel coal, which is extremely rich in carbon oils and of a remarkoble dense structure, appears to be made up entirely of Stigmaria stems and leaves and Lepidodendron. One seldom splits a block of this cannel coal without finding in it marks of stigmaria or Lepidodendon well defined by a coating of pyrites. The wash coal at the bottom of this seam contains Lepidodendron, Calamites and Stigmaria. The roof is formed of a heavy bed of black bituminous shale, containing fragments of ferns and *Lingula umbonata*. I accompanied Prof. Leo Lesquereux on a visit to the Breckenridge coal in 1857 and his observations on its flora are given in 3d Vol., Ky. Rep., p. 532.

Here then we find one of the best oil producing cannel coals in the country, actually made up of the remains of air breathing plants. But since the roof shales contain the remains of marine brachiopods there is evidence that salt water was close at hand and may have had something to do in forming the character of the coal. Breckenridge cannel coal, according to Dr. Peters analysis, contains:

Moisture	1·30
Volatile matter	54·40
Carbon	32·00
Ash	12·30

The elementary analysis gave—

Carbon	68·128
Hydrogen	6·489
Nitrogen	2·274
Oxygen and loss	5·833
Sulphur	2·476
Ash	14·800

On the Proximate Composition of Coal-Gas.

Read before the British Association, Glasgow Meeting (Section B.)

BY W. DITTMAR,

Professor of Chemistry in the Andersonian University, Glasgow.

In a memoir, "Sur le Gaz d'Eclairage," which he published some months ago in the *Comptes Rendus*, M. Berthelot reports on a most elaborate proximate analysis of the Paris Gas, which brought out the startling result that that gas contained only 3·7 per cent. of heavy carburetted hydrogens, and that these 3·7 per cent. included of—

Benzol	3·0 to 3.5 per cent.
Acetylen	0.1 "
Ethylen	0·1 to 0·2 "
Propylen and other hydrocarbons	0·02 "

In other words, the gas was found to contain only about 3½ per cent. of things *not* diluents, and that these 3½ per cent. consisted substantially of benzol only. Regarding the experimental evidence adduced, it may suffice here to state that the sum total of heavy carbides was determined by absorption with bromine, and that the volume of the benzol vapor was identified with the contraction suffered by the gas when shaken with fuming nitric acid.

From the numbers just quoted it would appear that the Paris gas, as analyzed by Berthelot, has quite an exceptional composition, owing perhaps to an exceptional mode of manufacture. This, however, is not the view which Berthelot takes of the matter. He does not hesitate to extend his results as applying substantially to *illuminating gas in general*, these results, he says, being in perfect accordance with what he had found out long ago regarding the pyrogenic relations of carburetted hydrogens.

Now it so happened that at the time when Berthelot's memoir reached me I was just engaged in collecting materials and apparatus for investigating, by synthetical methods, into the extent to which the several constituents of a coal-gas contribute to its illuminating power: I accordingly read Berthelot's paper with the greatest possible interest, and at once decided upon looking into the matter.

I will begin by offering some remarks on the manner in which Berthelot tries to account for the fact that all previous coal-gas analysts, instead of his few per milles, invariably found large percentages—sometimes as much as 10 per cent., and even more—of olefines. Berthelot's explanation is this:—Until now analysts (in attempting to determine the composition of their olefines) have entirely relied on the eudiometric method of combustion, and "la traduction de leurs resultats par les noms de.....est absolument erronée comme repasant sur un simple jeu d'equations algèbriques, calculées dans l'hypothèse de certaines inconnues qui ne sont pas conformes à la realité." Now this, I think, is putting it rather strongly. It is quite true that gas analysts hitherto have not always kept quite alive to the obvious proposition that the combustion of a gas cannot by any means give us more than the quantitative elementary composition of the unit volume, and that consequently the reporting of so-and-so many per cents. of ethylen, butylen, &c., is nothing more than a rather clumsy *modus* of stating the volumes of carbon-vapor and hydrogen in the part condensable by bromine or by fuming oil of vitrol. But it is possible to assume that in the many coal-gas analyses which have been published by Bunsen, Landolt, Frankland, and others, the numbers which to these chemists served as a basis for their calculations should have been so entirely wrong as to enable them to turn into CnH_{2n} what in reality consisted mainly of C_4H_8?

Let us look at an example. Bunsen, in his "Gasometric Methods," gives all the details of a complete analysis of a sample of Manchester coal-gas, in which his "ethylen" and "ditetryl" (C_4H_8) were calculated from the following data:—(After removal of H_2S and CO_2) 11·1 vols. of the gas gave up to fuming oil of vitrol 0·747 vol. To determine the carbon and hydrogen in this 0·747 vol. two combustions were made, viz., one of the original gas, and, secondly, one of the parts not condensable by SO_3; and from the result it appeared that the "olefines," if burned by themselves, would have given—

A contraction of 1·747 vols.
CO_2 " 2·089 "

Now these numbers show that, whatever may have been its *proximate* composition, the elementary composition of the "olefine" was $C_{1\cdot05}H_2$ = say 0·75 vol. (which is near enough), and, neglecting the small excess in the carbon, we see that these numbers agree with the hypothesis that the absorbed gas consisted of—

C_2H_6=2 vols. of propylen, and
$\frac{1}{2}C_2H_4$=1 vol. of ethylen.

It is true there *is* room for a little benzol. To find a maximum limit for this potential benzol, let us assume the observational errors had made the carbon too high and the hydrogen too low, and take x=1·1 and y=1·8, instead of 1·05 and 2·00 respectively. If we do so we find—

Benzol..... 0·13 vol.
Olefines..... 0·62 " } or $C_{2\cdot25}H_{4\cdot82}$ in 2 vols.
containing $C_{0\cdot7}+H_{1\cdot4}$ }

We see that what was put down by Bunsen as so much of a mixture of C_2H_4 and C_4H_8 could not well be assumed to have contained much above 17 per cent. of benzol.

No doubt if we went to the trouble of re-calculating, in a similar manner, the coal-gas analyses executed after Bunsen's method by Frankland, Landolt, &c., we should arrive at similar results. I prefer passing now to a series of experiments which I made for ascertaining to what extent Berthelot's views hold with regard to Glasgow coal-gas.

The first experiment I made was to pass a current of the gas through a long column of nitric acid, of 1·5 sp. gr., into a glass gas-holder, and then to compare the illuminating power of the product with that of the original gas, a "fish-tail" burner being used in both cases. The flame of the de-benzolated gas was only very feebly luminous, which, at the time, I felt inclined to accept as strong evidence of the absence in the gas of any considerable quantity of olefines; but not feeling quite sure on this point I tried some experiments on the luminosity of synthetically prepared mixtures of hydrogen and ethylen. To my surprise I found that the addition (to 1 vol. of C_2H_4) of only 3 vols. of hydrogen sufficed to bring down the luminosity to about the level of marsh-gss, while a 10 per cent ethylen flame was no more luminous than that of a Bunsen's lamp! On the other hand, a mixture of *benzol-vapor* and hydrogen, which (by combustion of a measured volume with oxide of copper) had been proved to contain 3 per cent of benzol-vapor (equal in carbon to only 9 per cent. of C_2H_4), was found to give a brilliantly luminous flame.

These results render it highly probable that the light-value of a coal-gas depends far more on the proportion of benzol than on the proportion of olefines contained in it. This, however, has nothing to do with the question on hand. More nearly related to it is an observation which I made incidentally in preparations of benzolated hydrogen. The 3 per cent. gas above referred to had been made by passing hydrogen slowly through a bulb apparatus charged with benzol, and kept at about 18° C. From the bulb apparatus the gas was made to bubble up through water into a gas-holder. Now, according to Regnault's tension determinations, the gas should have contained about 10 per cent. of benzol-vapor, and yet it contained only 3 per cent. I could not explain this otherwise than by supposing that the greater part of the vapor originally present had been dissolved out by the water in the gasometer. To test this hypothesis a quantity of benzolated hydrogen, kept over mercury, and proved by combustion to contain 6 per cent. of C_6H_6, was shaken with water and again analyzed. The percentage of benzol-vapor was reduced to less than 2.

After these experiences I felt convinced that, although coal-gas as it comes out of the retort cannot help containing a considerable proportion of benzol, only very little of this vapor will survive the subsequent processes of purification. And having previously found that Glasgow gas when shaken with bromine contracts about 10 per cent., I had no doubt in my mind that the greater part of this contraction must be owing to olefines.

Wishing to determine the exact ratio in the gas between the benzol and the olefines, I tried very hard to find out a quantitative method for their separation from each other; but I did not succeed. That *nitric acid* of 1·5 is *not* the proper reagent for the purpose a few experiments were sufficient to show—some made with pure ethylen, others with synthetically prepared mixture of this gas with benzolated hydrogen of known composition. In all cases the acid was found to act on the ethylen as well as on the benzol: no doubt with formation of Kekulé's—

$$C_2H_4 \begin{cases} NO_2 \\ NO_2 \end{cases}$$

and equally unfavorable results were obtained when 1·4 acid was substituted for the 1.5. For a time I thought an approximate separation, at least, could be effected with fatty oils or heavy paraffin-oils, but it turned out an illusion; a considerable quantity of ethylen always accompanied the benzol in its absorption by these liquids.

The last substance I tried was non-vulcanized india-rubber, and, if I may trust a few preliminary trials, it *does* seem to have the power of abstracting the benzol from a gas without condensing much of the ethylen. I have, however, not yet found the time for trying *exact* quantitative experiments.

In order to form an idea of the proximate composition of the olefine portion of Glasgow gas, a current of it was made to pass (1) over dry chloride of calcium, (2) over a coil of sheet india-rubber, and (3) through a long slanting tube charged with bromine. The bromine soon got almost entirely converted into a liquid bromide, which was washed with dilute caustic soda, dried with fused chloride of calcium, and distilled. A *considerable* portion distilled below the boiling-point of propylen bromide (142°). The percentage of bromime was found to be 83·52, whence, assuming the composition to be $CnH_{2n}Br_2$, we have—

CnH_{2n}=31·6; C_2H_4=28; C_3H_6=42.

When a weighted quantity was treated on a water-bath with alcoholic potash, a large precipitate separated out, which was found to contain more than half of the bromine originally present in the substance.

These experiments clearly show that the substance consisted substantially, *not* of mono-bromo benzol (C_6H_5Br, which is *not* decomposable by alcoholic potash), but of bromides, $CnH_{2n}Br_2$, in which the lowest term, $C_2H_4Br_2$, must have been very largely represented.

From the foregoing it is clear that, contrary to Berthelot's assertion, the constitution of the heavy carburetted hydrogen portion in coal-gas is pretty much what it has always been supposed to be.

I have to thank my friend Mr. W. J. Curphe the excellent manner in which he has assisted m this little investigation.—*Chem. News*

Process for the Manufacture of Soda from Seaweed by Endosmotic Lixiviation.

By M. L. Herland.

The author gives the following reasons for the depressed state of the seaweed industry; the weed is collected indiscriminately without regard to its greater or less richness in iodides or other useful salts. The weed destined for incineration is dried on the shore in the open air, whence results a decomposition and a loss of salts from the spray of the sea, dew, rain, etc The process of incineration itself is the main cause of the weakness of the product in iodine, as a certain quantity is volatilised, but it is chiefly to the siliceous sand mixed with the weed that the great loss is due. In fact, silica at high temperatures reacts upon the iodides, producing alkaline-earthy silicates, and eliminating a certain quantity of iodine. The author, therefore, proposes the following method:—The fresh weed is placed in baskets of iron wire, moved by a turning crane, and steeped in a series of vats containing about 50 kilos. of good quicklime per cubic metre of water, and arranged in circular batteries. The weed passes in succession from vat to vat, and is exhausted of all its useful salts. The same series of successive immersions is pursued with fresh weed until the first vat marks 4·3° to 4·5° on the hydrometer (pése-sels, probably a Baume's glass adapted for saline solutions). During this operation a double exchange takes place between the weed and the lime-water, by means of endosmosis. The time of steeping is, on the average, from forty to sixty minutes. With a set of ten vats of 6 cubic metres, it is possible to lixiviate in fifteen hours 50 tons of 1000 kilos. each of fresh weed. The second stage of the operation consists in evaporating to dryness the successive saturated lyes, and then calcining very slightly in the presence of a slight excess of carbonate of potash, carrying the process to the commencement of the aqueous fusion. This proceedure yields a soda very rich in soluble salts, in utilisable salts of potash (chloride and sulphate), and in alkaline iodides. The incineration process gives, on an average, 15 per cent. of potash salts and 1 per cent., at the outside, of iodide. The new process yields 45 to 50 per cent. of utilisable salts of potash, and 2½, 3, or even 5 and 6 per cent. of iodide if the weeds have been well-selected. The residual weeds are still applicable in agriculture.—*Chemical News.*

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FRIDAY, FEBRUARY 16, 1877.

A Dirty. Mean Trick.

[Written for the Titusville Herald.]

"A dirty, mean trick," so says Mr. X., who uses gas in his house, but prefers kerosene oil in his tea establishment down town. Mr. X. had received his gas bill for the month. He took this bill home, compared it with the meter dials, made a few curt inquiries, and after anathematizing the extravagant habits of the family generally, started for the gas man's office. Mr. X found the gas man undergoing a vindictively classical blackguarding by a consumer whose gas had been stopped, in consequence of the non-payment of several months bills, this terminating by the gas man being told to charge the account to profit and loss. Mr. X presented his bill to the official recipient of chronic abuse and requested to have it read aloud to him. The gas man read, "2,200 feet from 2,800 feet is 600 feet; 600 feet at $3.50 per 1,000 is $2.10 and 30 cents off for prompt payment leaves $1.80. Shall I receipt it, sir?"

"Receipt paradise?" said Mr. X. "That bill's 300 feet more than last month's, and last month's was a heavenly sight more than it ought to have been: it is too sanctified bad, by Pluto; I'd rather burn oil a blessed sight; I go patronizing the gas company and doing my best to help 'em along, and here it is, here's what I get, one month doubling another right straight along, and heaven to pay generally."

The gas man suggested that possibly the long nights had something to do with the increased consumption, possibly extra company, probably the family sat up later holidays, perhaps the family used gas these dark mornings; might not the gas have been left burning through the night; had they a new servant, etc., with other suppositions that might account for an extra bill, and finally that the bill was a light one anyway for Mr. X's premises and the number of jets in use, and that if Mr. X desired he could have the meter tested to his satisfaction.

Mr. X blessed the meter and asseverated that his family retired regularly, and early at that, never breakfasted before 8:30 mornings, didn't have any company, didn't observe holidays, always turned the gas off himself, had no servant, more than this he had been economizing, didn't use the hall light unless somebody called, furthermore he had bought three extra oil lamps with a still further view of cutting down the gas bill, entailing the consumption of two gallons more kerosene than in the previous month, and that anyway by the finite pollywog the gas was too blest poor to be seen without the aid of half a dozen oil lamps, and finally he had shut off the gas himself, and that the gas company could go to glory or collect the bill whichever they best pleased, and he meant business, and Mr. X took his departure.

The gas man was accustomed to this sort of pleasantry. He never anticipated any other sentiment on the part of the consumer. Once and once only, it is stated, a consumer remarked that his bill was less than he anticipated; in short, he had nothing to complain of there. The astonished gas man doubted his senses; he wasn't himself all that day; but it made a new man of him—he connected himself with that church of which the conscientious consumer was an active member, and assisted in the Sabbath schol from that time forward.

But now for the meanness: The gas man dealt with Mr. X; the gas man had ordered, some time during the past montb, a pound of the best imperial tea; early in the present month the gas man dropped into Mr. X's ettablishment and desired to know the amount of the indebtedness; Mr. X presented a bill for $1.75 for one pound of best imperial tea; the gas man demurred to the amount charged for; Mr. X stated the bill was all right and the tea had been delivered at the gas man's house; the gas man protested that he could not have received the amount of tea, as it had not *held* out as long as the last pound of tea; that the family were out of green tea already, whereas, by rights, there should have been enough to last a week or ten days longer. Mr. X answered that he had nothing to do with that, a pound of tea was a pound of tea anyway, and would hold out only as long as a pound of tea, and that the gas man's family must have been using more than usual, wasting or spilling it; anyway, he did not himself propose keeping track of goods after they had been fairly weighed and delivered to the customer; it made no odds to him how the gas man's family used it; the gas man must look after his own affairs and he (Mr X) had no doubt that if the gas mans wife looked after things herself instead of trusting to a parcel of hired help, it might be a saving in more things than tea. The gas man persisted that he kept no hired help, that his family had been out of town a great part of the month, that during that time he took his meals down street, that when at home they had been unusually economical in the use of imperial, that the imperial was not as good as it ought to be, in fact he had bought a pound of black lea to impart tone and color to what otherwise would have been undistinguishable from warm water, and add to this that it had cost the family more for coffee that month than in any previous two; he didn't care for tea himself personally, but mainly desired the welfare of Mr. X's business and was anxious to give him a lift, and finally as it was to be supposed that neither Mr. X nor the gas man were dishonest or intended to lie, that Mr. X must take the gas man's word in regard to the tea account, and the gas man would take Mr. X's word as to the gas statement and call the account square, which would leave Mr. X five cents ahead. Mr. X promptly answered, "it was too blessed thin and he couldn't see it."

As there have been no further negotiations on the subject it is still in *statu quo*, but Mr. X goes around the village denouncing the gas man as a dead beat, and characterizing the proposition to square off accounts as a "dirty, mean trick." The gas man answereth not again, but is supposed to have some opinions of his own on the subject of dead beats.

Gas-Light Intelligence.

United States.

We are informed that the proprietors of the Lowe Process have made contracts for the introduction of their gas into Baltimore, Reading, and Indianapolis.

We have received a reply to V's communication on "Tar Fuel" in our last issue, from J. We regret that it came too late for this issue, but shall give it in our next.—EDITOR.

LEAKS IN GAS PIPES.—To detect leaks in gas pipes, apply soap suds to the suspected leaky joint. The formation of bubbles will show an escape. This is safer than trying the joint with a lighted match. If the leak occur in the branch of a bracket or chandelier, it is repaired by soldering with plumber's fine solder; if it be a very small one, heat the piece first with a spirit lamp, and fill the aperture with cement.

ST LOUIS VS. ST. LOUIS GAS COMPANY.—Judge Gottschalk, of the Circuit Court, this morning (February 12) issued a final decree in the suit of the City against the St. Louis Gas Company, giving the city all the works and property of the company and $40,000 in cash. This differs from the former decree only so far as it reduces the amount of money awarded to the city from $207,000 to $40,000.—*N. Y. World.*

OFFICERS OF THE MUNICIPAL GAS-LIGHT CO., N. Y. CITY.—Chas. G. Francklyn, President and Treas.; Phillip Allen, Secretary.

DIRECTORS.—Chas. G. Francklyn, Peter Gardener Samuel Hawk, L. Delmonico, Theo. Weston, Geo. W. King, Ramsey Crooks, Wm. Schwartzwaelder, R. M. C. Graham, A. Jackson Dam, Geo. H. Bissel, Henry Day. Office 952 Broadway, N. Y. City.

Great Britain.

EXPLOSION OF GAS AT BROMSGROVE.—On the 22nd ult., the manager of the Bromsgrove Gas Company, assisted by a lad, was endeavoring to discover an escape of gas in the road adjacent to some newly erected houses. A deep cutting had recently been made by the contractor, in order to connect the drainage of the houses in question with the main sewer, and the state of the road in this part has necessarily been soft and "giving," through being imperfectly rammed, or not rammed at all. While employed in searching for the leak, a violent explosion occurred in the rear of the premises themselves, and in the gardens connected with them. On examining the premises it was found that the archings turned over two cisterns, formed for supplying the houses with soft water, had been blown off with terrific force, carrying with them the doors, the hinges of which were torn off as though they were brown paper, and in one case carrying the large stone covering of the man-hole of one of the cisterns completely through the ceiling. The heavy stone covering was also blown off the dumb-well, the masonry of which, as well as the cement lining and the masonry of the wash-houses, was very much damaged. At first the origin of the whole affair seemed enveloped in mystery, but subsequent examination showed that a gas-pipe crossing the cutting had been broken in two, probably by a heavy load passing over the newly-moved earth: and the escaped and escaping gas had found its way up the surface drain-pipe and into the soft-water reservoir and dumb-well, where it had accumulated, and a light having been brought into the vicinity, the explosion occurred.—*Lon. Jour. of Gas Lighting.*

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—ED.

High and Low Level Sites for Gas Works.

MONTREAL. February 8, 1877.

MR. EDITOR: Mr. E. S. Stultus clearly does not believe in the views advanced in some remarks on the above subject, in the paper read by your humble servant, at the last meeting of the Gas Light Association, in which the popular preference for the lowest levels for gas works, as being the best for distribution was

questioned; and he purports to prove to a demonstration, by a "short and easy method," the fallacy of my reasoning.

Mr. Stultus's A B C and "double X" example is unexceptionable *as far as it goes*, and his conclusion apparently irresistable. X does certainly appear equal to X, yet in spite of this equality there is, it seems, a difference. Six are equal to half-a-dozen, *and* something more. which something more, we are informed, consists in B having the "disadvantage of a higher initial pressure." Your correspondent being evidently of a mathematical turn of mind, will perhaps favor us with a "demonstration" of said disadvantages. It will doubtless be interesting.

Mr. Stultus's modesty and hesitancy are unique. He is surely the most sceptical of mortals. Ill natured people might even fairly accuse him of "stultifying" himself. It having been demonstrated that A equals B, "X equals X," or that twice two equals four, it might be thought that there was neither room for doubting, nor merit in believing, that is, to the ordinary mind. But as the material cannot comprehend the immaterial, so neither can the ordinary comprehend the extraordinary mind, and it may be, who knows, that to such a gifted bieng, doubting a demonstration comes as easy as eating one's porridge.

Mr. Stultified Stultus, in irony as keen as a cow's tail, says "because it appears thus to my ignorance, and I cannot make it right, I have written to ask the favor of an explanation *on the basis of the above illustration.*" Exactly. Come into my garden said the spider to the fly. This child was born a little too far north to be caught in such a clumsily baited trap as that, my friend. Duly according my sense of the prettiness and convenience of the illustration of the "two towns" made for the occasion, and having I hope gracefully acquiesced in the inexorable logic displayed thereanent, I must be permitted to decline any "explanation" of other instances. "on the basis of the above illustration."

Having now replied, I hope to Mr. S's satisfaction, I would, with all due humility, in turn ask how it would be for day pressure, if the works were situated on the level of A, and there were two or three "parallel streets" on successively higher levels, say B, C, and D; D being as much above C, as B above A? I pause for a demonstration of the equality of the "X's"; and not being in the habit of skulking behind a mask, in saying what I have to say, I openly subscribe myself, E. S. CATHELS.

Lowering Water Mains.

GRAND RAPIDS, MICH., Feb. 2, 1877.

Mr. Editor: In your issue of the 2nd inst. is an interesting account of the methods adopted in San Francisco to lower a water main to conform to new grades, without severing the pipe or breaking joints. The process, namely, suspending the pipe and lowering by screws, is spoken of as highly creditable to the engineer. The same method was used here about two years since by our city engineer, Colonel E. W. Muenscher, to place a line of pipe eight hundred feet long across Grand River in this city, in a channel cut in rock to receive it, under water four feet deep, and again to lower a line of large street main about the same length, no leaks having been developed since the experiment was tried.

THOMAS D. GILBERT,
President Board of Public Works.

Gas Stocks.

Quotations by W. B. Scott & Co., Bankers,

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FEBRUARY 2, 1877.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.

	Capital.	Par.	Bid.	Asked.
Harlem	$1,850,000	50	105	110
Manhattan	4,000,000	50	230	235
Metropolitan	2,500,000	100	145	150
" Scrip	$1,000,000	...	100	103
" Bonds	500,000	1000	100	103
Mutual	5,000,000	100	103	—
" Bonds, gold.	900,000	1000	105	—
New York	4,000,000	100	130	131
Gas Co.'s of Brooklyn.				
Brooklyn	2,000,000	25	175	180
Citizens	1,200,000	20	97	100
" Scrip	320,000	1000	95	97½
Peoples	1,000,000	10	50	55
" Bonds	$ 325,000	...	—	95
" Scrip	300,000	...	85	—
Metropolitan	1,000,000	100	76	80
Nassau	1,000,000	25	80	85
" Ctfs.	700,000	1000	96	98
Williamsburgh	1,000,000	50	135	140
" Scrip		...	98	100
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N. Y	750,000	100	—	80
" Bonds	200,000	1000	—	90
Baltimore, Md.	2,000,000	100	150	170
" Ctfs., gold	1,000,000		105	—
Bayonne, N. J.		100		90
Brockport, N. Y.	25,000	100	...	80
Citizens, Newark	918,000	50	98	100
" " Bds.	124,000	—	—	—
Derby of Conn	160,000	100	60	80
East Boston, Mass.		25	132	—
Fort Wayne, Ind.		100	...	—
Hannibal, Mo.	100,000	100	95	100
Hartford, Conn.	700,000	25	152	—
Hempstead, L.	25,000	100	...	—
Jersey City	386,000	20	160	—
Jamaica, L. I.	25,000	100	...	—
Jacksonville, Ill.	120,000	50	82	...
Lewistown, Maine	400,000	100	50	85
Lima, Ohio	60,000	100	—	...
Bonds	30,000		90	
Laclede, St Louis Mo	1,200,000	100	100	110
Peoples, Jersey City		...	120	125
Leoples of Albany	650,000	100	—	20
" Bonds	350,000	1000	—	—
Peoples of Baltimore		25	99	100
" Bonds			106	—
Perth Amboy		25	—	95
Rochester, N. Y.		100	50	60
Richmond Co., S. I.	300,000	...	97	100
Woonsocket, R. I.	150,000	100	100	...
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150,000	40	112½	
San Francisco Gas-Co., S. Fr'isco Cal.			99	100
St. Louis, Missouri	600,000	50	—	100
Stillwater, Minn.	50,000	50	—	26
Suburban, W'stch'str	390,000	50	—	100
Saugerties, N. Y.	15,000	100	110	115
Troy, Citizens	600,000	100	—	100
Central, Westchester	466,000	50	90	95

The Metropolitan Gas Company of New York have declared a dividend of 5% on stock, and 3½% on scrip, payable on demand.

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Patent Gas Exhauster—Smith & Sayre, 95 Liberty sttreet.
Patent Gas Exhauster—S. S. Townsend, Agt., 31 Liberty street, N. Y.

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National Coal Gas Company—H. P. Allen, 4 Warren st., N.Y.
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Screening Shovels—Herring & Floyd, 740 Greenwich street New York.
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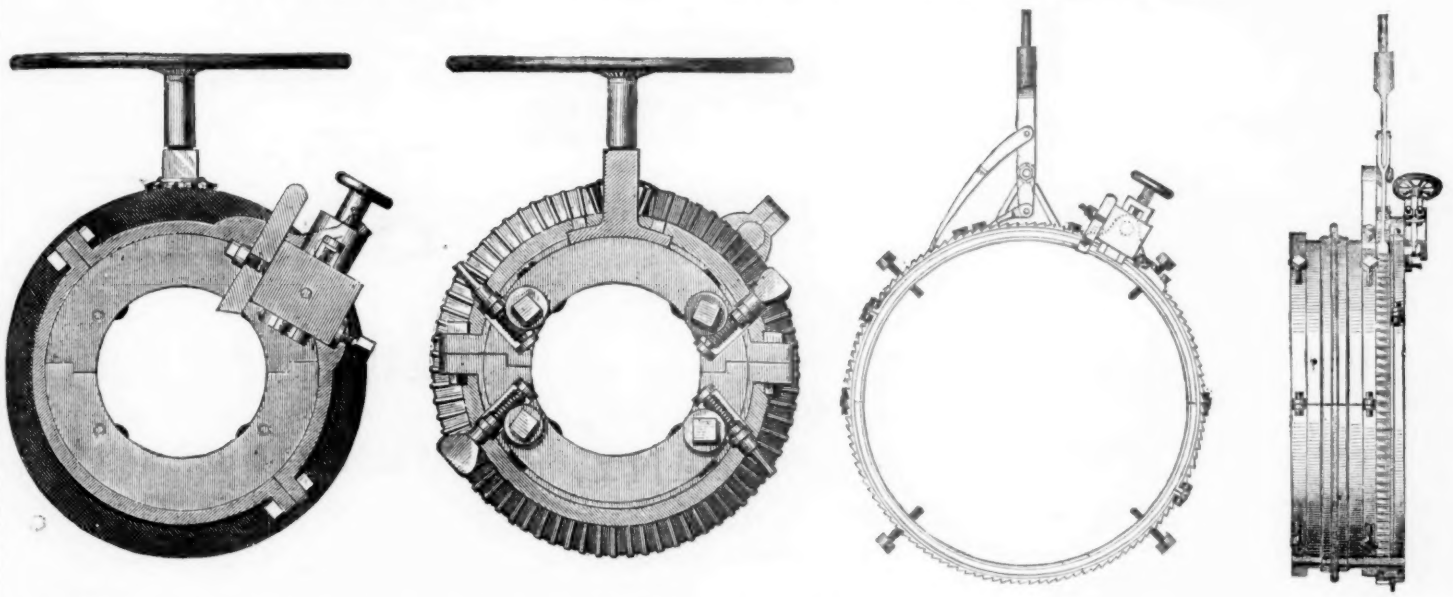
PATENTED MAY 23rd, 1876.

THIS IS THE ONLY HAND MACHINE IN THE WORLD FOR CUTTING

CAST IRON PIPE.



It will cut Cast or Wrought Iron Pipe, Shafts, or Columns of any size, making a clean, smooth, and square cut.

A Continuous Line of Pipe in a Trench or Building

cut, as well as Loose Pipe.
Our Machines for cutting 30-INCH PIPE have been furnished to the Manhattan and New York Gas Light Companies, and operate to their entire satisfactio
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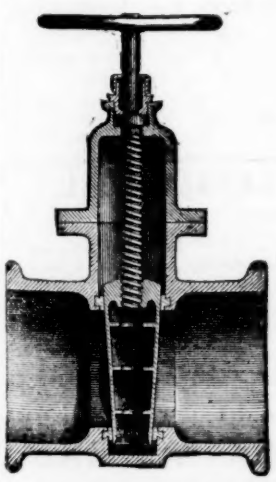
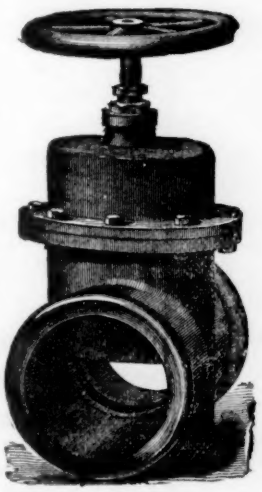
CHAPMAN GAS VALVES.

Office and Sales Room 75 and 77 Kilby Street, Boston.





These Valves have been in use for several years, and are pronounced by all who have used them to be

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They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves. It does not corrode under any circumstances to which it is exposed.

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CITIZENS GAS-LIGHT COMPANY, BROOKLYN, N. Y.
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CHARLESTOWN GAS-LIGHT CO., CHARLESTOWN, MASS.
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357-tf

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PENN GAS COAL COMPANY

OFFER THEIR

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AND PREPARED FOR

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☞ SEND FOR CIRCULAR AND PRICE LIST. ☜

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A HALF INTEREST IN A SMALL GAS WORKS WILL be sold, or leased to a practical gas man. Two thousand feet of natural gas per day. Address

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IMPROVED GAS EXHAUSTER,

WITH ENGINE ATTACHED ON SAME BED PLATE.

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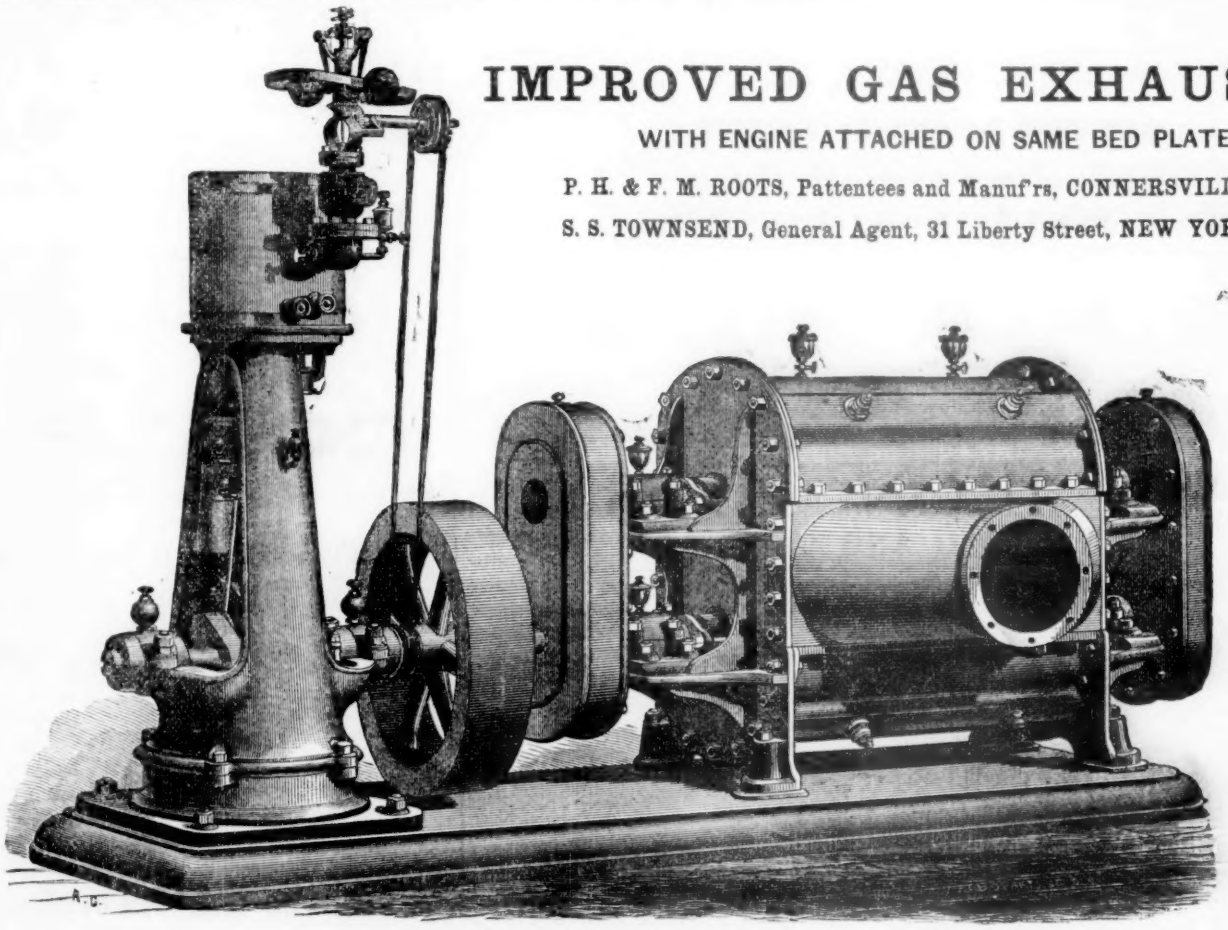

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4. They are built in the most complete and substantial manner, and of any required size, with steel shafts and improved journal bearings.
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6. We also furnish Bye Passes and Gas Valves on improved plans, also Exhauster Governors and Elbows, Pipes, Drawings, etc.

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It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,792 cubic feet, with a large amount of coke of good quality.

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Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.

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OFFER THEIR SUPERIOR
DESPARD COAL

To Gas Light Companies throughout the country.
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Mines in Harrison County, West Virginia.
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Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine

☞ Reference to them is requested. 204-

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RETORT WORKS.

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☞ Articles of every description made to order at short notice. 105

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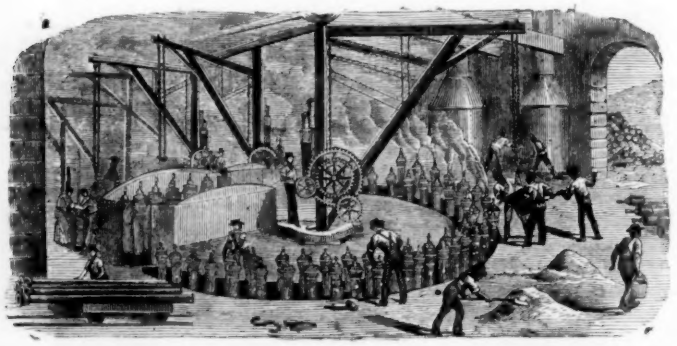

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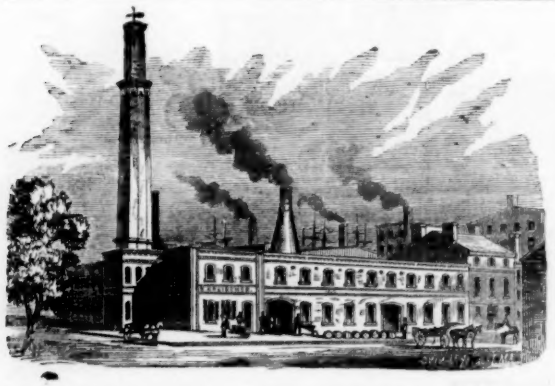

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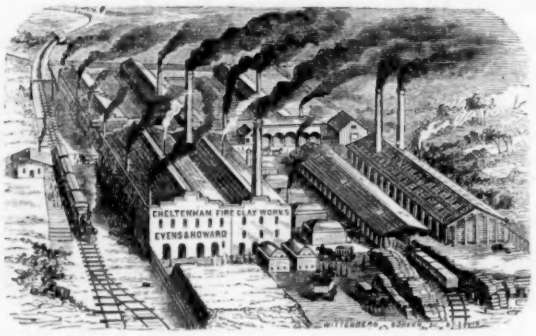

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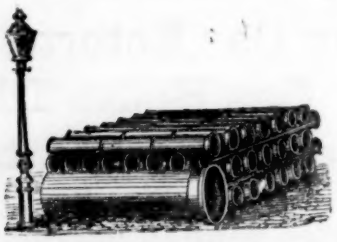

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It will be to the advantage of Gas Companies to supply their Consumers with one of these Guides, as a means of preventing complaints arising from their want of knowledge in regard to the registration of their meters. For sale by

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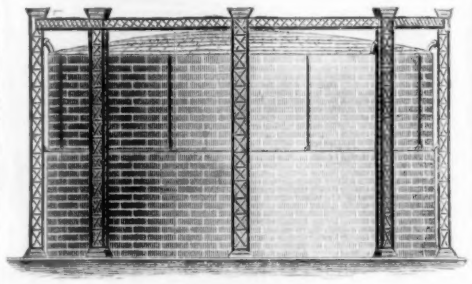

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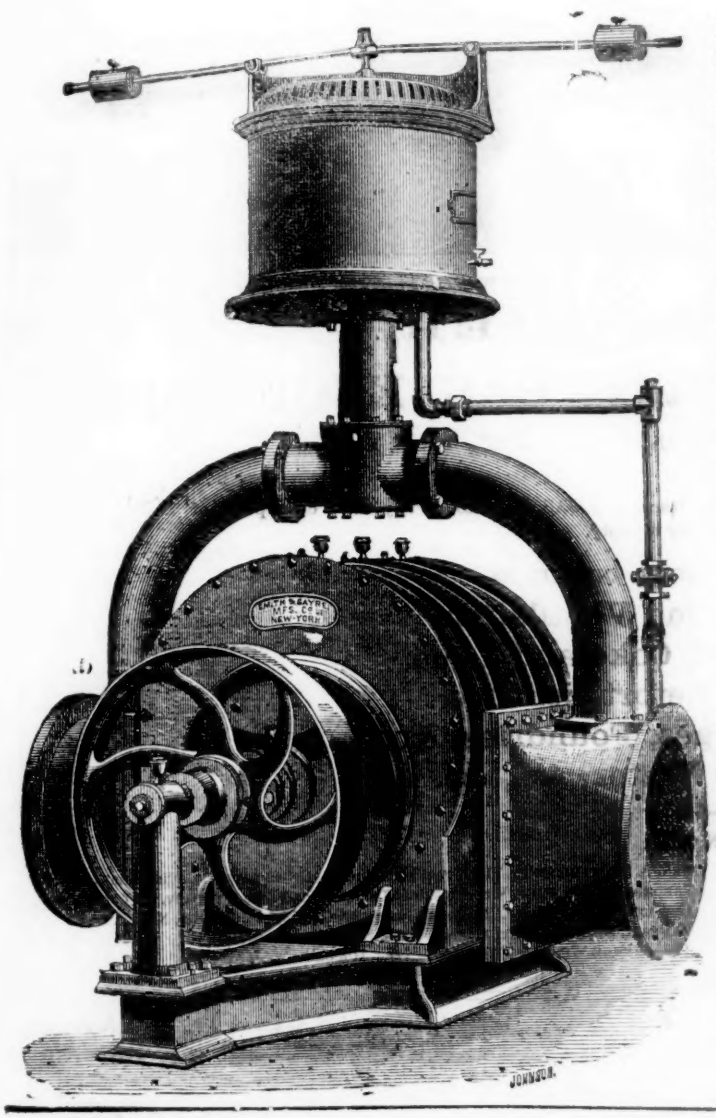

They are made to pass from 4,000 to 150,000 cubic feet of gas per hour; will increase the production and illuminating power of the gas and add very much to the durability of the retorts, either clay or iron. The Compensator obviates entirely the necessity of water-jo ints, is compact, durable, cleanly, not liable to get out of order, self-acting, quiet, and certain in its operation.

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The Blower is a Force Blast machine, durably built, and can be driven with one-third the power required to drive the ordinary Fan

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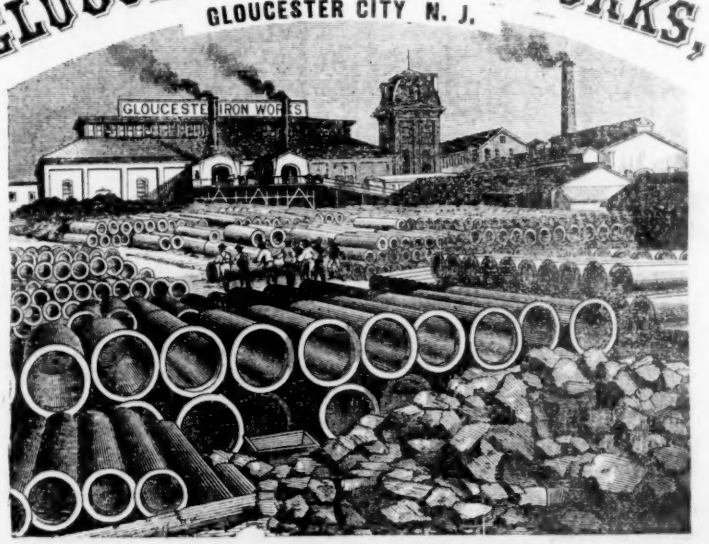

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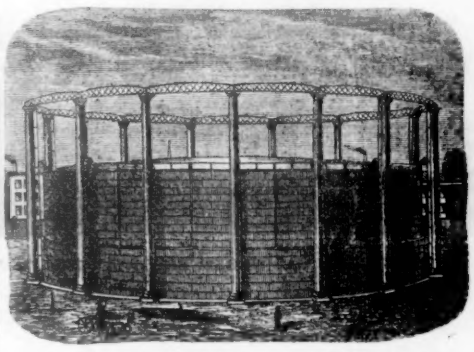

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With cast iron guide and suspension frames. GAS GOVERNORS or REGULATORS, STREET MAINS, from 1½ to 48 INCHES DIAMETER, for WATER or GAS. Street Main connections, such as BRANCHES, BENDS, DRIPS, SLEEVES, etc.

STOP VALVES, from 3 to 30 inches, for both Water and Gas.

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All the Smith and Sheet Iron work required in and about Gas Works. 226-tf

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CHARLES MACKALL, Secretary.

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This coal yields 10,000 cubic feet of Gas, with an illuminating power of over 16 candles. Forty bushels of very superior Coke, with little Ash and scarcely any clinker 64-1y

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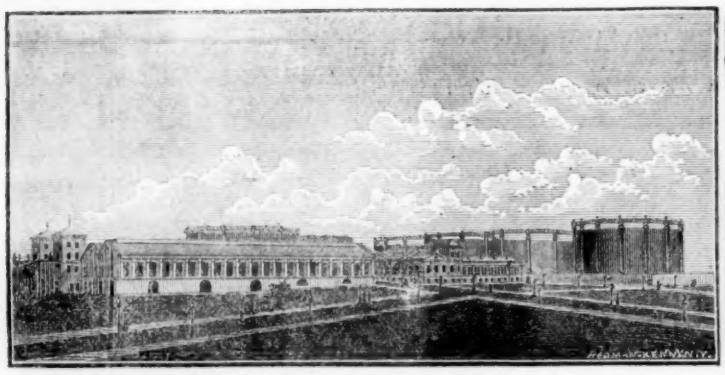

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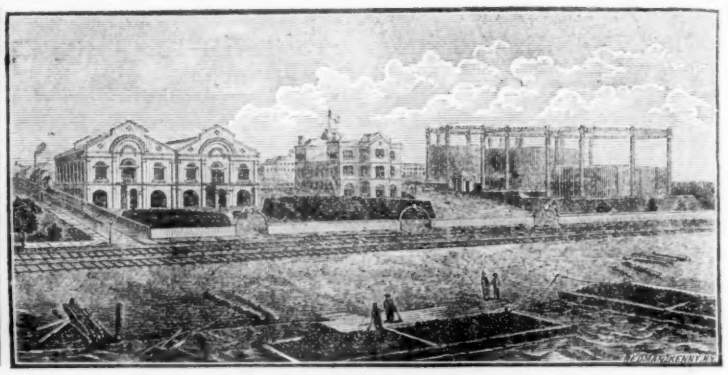

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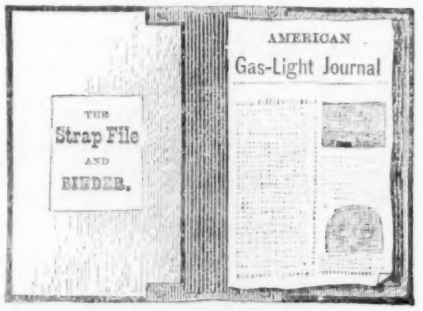

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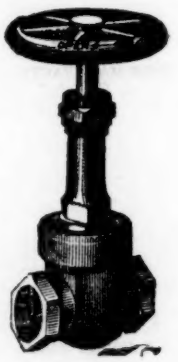

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